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The Sales Engineer

"HE is a born salesman," is an old expression that continues to survive, but how many executives stop to consider the qualifications of the real salesman? His success is too often determined by the volume of business secured, rather than by the number of satisfied customers. The conservative salesman, whose business is small by comparison, is frequently relegated to the ranks of the inefficient to make room for this new type of oratorical wizard.

The smooth-tongued, sportily dressed "order getters" should be given no quarter on the sales organization of the present day manufacturer, when an enviable reputation, acquired by years of conscientious effort, is at stake, yet too many concerns tolerate such conditions.

Requisite qualifications for the successful salesman are a thorough and intimate knowledge of every feature of his merchandise, and the properties it must possess to fit it for every use. Such a man is not a salesman, he is an engineer, a sales engineer; and will command the respect and confidence of his prospective customers.

Progressive manufacturers endeavor to produce a product that will serve the requirements of the majority of users, but frequently cases arise where a special construction is necessary. The sales engineer, who has the ability to grasp the situation, is of inestimable value under such circumstances, and by correctly conveying such information to his employer, performs a service of mutual benefit to producer and user.

Salesmen too often assume the attitude that the customer is ignorant and does not know what he wants. Do they ever stop to consider that each individual in an organization is hired for his ability to produce, and, if he fails, there is always someone to take his place? He may not always be informed of the very latest improvements and developments in all lines, but being a pretty decent sort of a chap, is usually in a receptive mood for such information.

After all, common sense mixed with a little diplomacy is the best policy, and usually results in customers that are boosters.

Sheet Steel—Specification and Inspection

Improved Methods of Testing and the Insistence That Certain Definite Standards Be Met Has Had Much to Do with Improving the Quality of Sheet Steel

By L. N. BROWN*

THE comparatively recent increase in the use of sheet and strip steel has so largely escaped the attention of the average technical man that an examination of production records causes considerable surprise. The amount produced for the automotive trade alone can be roughly estimated when it is realized that over half of the weight of the steel used in the manufacture of the average car is of this character. The applications which are developing in other lines are almost as numerous and the field seems to be enlarging daily.

With the advent of the automobile the bar mills were called upon to produce better steel on a tonnage basis. Alloy steels were developed and introduced, and their manufacture soon became standardized. Methods of testing were improved and with them came better control, better practice, and better steel. Competition was exceedingly keen and consequently the improvement has been exceedingly rapid. Necessity soon demanded that laboratories be established in automobile and allied concerns. The knowledge obtained was open to an ever increasing body of men as its importance was realized. As the results of research became more common knowledge, the pressure for better products became more evident, and these products have been gradually developed. Along this line the effect of improved methods of testing and the insistence that certain definite standards be met probably has had more to do with the development of better products than any other.

Careful Study of Steel Essential.

Until very recently the importance of a careful study of sheet and strip steel by the user has not been realized. The mills were not furnished with any real information regarding the users' needs, so that improvement in quality was consequently very slow. The specifications of surface, temper, etc., were made by the technical representatives of the mills usually after a somewhat cursory examination of the dies or blueprints of the part itself. At the present time more users are realizing the benefits to be gained from a careful technical study of this important material and are able to give definite information as to the requirements for each part. As a result, the product is steadily improving and will approach the degree of perfection of the bar stock products as soon as there is the same amount of co-operation as now exists between manufacturers and users of bar stock.

The real development of quality sheet and strip was also hampered for a long time by the fact that a real shortage of first class material existed and consumers were forced to use almost anything rolled. The mills working under pressure and being handicapped by inefficient methods and lack of modern equipment, were unable always to produce accurate work or to duplicate when necessary.

Daily more users are realizing their obligations in this line and are becoming familiar with the benefits to be gained from a careful technical study of this important material.

At the present time it is probably much more difficult to correctly specify on the blueprint the material to be used for a stamping than it is to specify the correct bar stock and heat treatment on a structural part. Unlike the case of the latter, no factor of safety is usually considered in designing the part or in the design of the dies and equipment used in processing. If sheet or strip steel will make the job without breaking it is usually considered to be strong enough to withstand road shock. On the other hand, structural parts may be made of steel which can be heat treated if necessary and whose properties may be varied over a wide range.

Surface Finish and Temper Important.

The two most important items of inspection procedure are the "surface finish" and the "temper." A close examination of these two properties with gauge tolerances which can be allowed and a study of the part, will usually determine whether strip or sheet will be specified. Other properties, which are occasionally necessary, are increased flatness (where slight buckles common to a commercial sheet are not permissible), extra stiffness, and special analysis. Oiling or liming, re-squaring, special edges and boxing or crating may also be requested.

The character of surface desired is usually governed by the use of the part or the method to be used in finishing; for example, whether it will receive two, three or four coats of baking japan (usually called enamel), be painted, lacquered, nickel plated or finished in some other manner.

Inspecting "Seconds."

The inspection of the surfaces of highly finished material which is to receive two coats without rubbing is a very difficult undertaking and one which demands close attention and a clear knowledge of what will cover properly and what will not. This knowledge is based upon experience gained in the use of the material and the various operations.

The policy and standards for inspecting seconds must be worked out and disposition made. This seems advisable as an immense amount of tonnage is placed with mills for odd sizes and they are usually given permission to ship up to 15 per cent of seconds. Otherwise the mills would have a heavy handicap and prices would necessarily be increased. Seconds are billed at a reduced price.

Besides the surface defects to which full finish stock is subject, the hazard of rust is added as a cause for rejection. This probably causes as large losses in finished parts as any of the others if adequate means are not provided for proper cleaning.

Prime stock is commonly understood to be stock which will require very little or no work to put it into

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*Inspection Division, Chrysler Corp., Detroit, Mich.

TABLE I—20 Ga. 34 x 108

Test No.	Date	Thickness	.250	.300	.350	.400	Broke	REMARKS
1	10-4-23	.035	2400	3000	....	....	.345-3200	Broke badly.
		.036	2450	3000	....	....	.340-3100	Returned to mills to re-treat.
		.038	2600	3000	....	....	.310-3100	
2	10-4-23	.038	2000	2800	3400	3800	.400-3800	Same as No. 1; after having been re-treated O.K.
		.038	2000	2650	3450	3700	.405-3800	
		.039	2000	2600	3400	3800	.415-4000	
22	10-16-23	.035	2100	2800	3300	....	.350-3300	This stock worked well.
		.0345	2200	2800	3200	....	.350-3200	
		.034	2200	2800	3300	....	.350-3300	
68	11-12-23	.036	2500	3200	3800	....	.370-4100	650 run.
		.036	2600	3300	3900	....	.365-4100	Breakage 1 per cent.
		.0355	2500	3200	3800	....	.370-4150	
75	11-16-23	.037	2400	3100	3700	....	.360-3850	150 run.
		.037	2300	3050	3600	....	.370-3900	No breakage.
		.037	2300	3100	3600	....	.365-3850	
76	11-16-23	.037	2700	3400	....	....	.310-3650	436 run.
		.036	2600	....	....	....	.295-3100	436 broke.
		.036	2700	3300	....	....	.300-3300	
96	1-4-24	.0375	2650	3500	....	....	.340-4200	Worked fair.
		.037	2800	3600	....	....	.350-4200	No breakage.
		.0365	2800	3500	....	....	.350-4200	Slight strains.
99	1-7-24	.037	2400	3150	3850	....	.360-4000	800 run.
		.037	2400	3150	3700	....	.365-3950	323 slight strains.
		.037	2400	3100	3600	....	.360-3900	No breakage.
128	1-24-24	.036	2500	3200	....	....	.330-3600	Run 1,000; broke 0.
		.037	2500	3200	....	....	.345-3800	Strains.
		.0365	2500	3200	....	....	.345-3800	
141	4-6-	.037	2200	2900	....	....	.340-3300	Run 2,000; broke 9.
		.039	2100	2800	3450	....	.350-3450	Strains 0.
		.038	2100	2900	3500	....	.350-3500	
304	10-8-	.035	2200	2700	3600	....	.365-3800	Strains heavy before and after roller leveling.
		.036	2100	2900	3700	....	.375-4000	
		.035	2200	3000	3800	....	.375-4000	

TABLE II—20 Ga. 36 x 110

Test No.	Date	Thickness	.250	.300	.350	.400	Broke	REMARKS
12	10-6-23	.038	2100	2800	3400	....	.385-3800	20 36x110
		.040	2100	2800	3400	....	.375-3700	500 run; breakage 1 per cent.
		.038	2100	2800	3300	....	.375-3700	Satisfactory.
26	10-18-23	.039	2300	3100	3600	....	.365-3800	750 run; breakage 2 per cent.
		.039	2400	3100	3650	....	.370-3900	Surface good.
		.040	2400	3100	3650	....	.370-3900	
33	10-26-23	.035	2100	2800	3300	3900	.405-4000	278 blanks run. Not roller leveled.
		.036	2000	2800	3400	4000	.405-4050	No breakage or strains.
		.035	2050	2700	3350	3900	.405-4000	
34	10-26-24	.036	2100	2800	3400	3800	.400-3800	Same as No. 33.
		.035	2200	2900	3400	3900	.400-3900	This strip was roller leveled.
		.035	2200	2800	3400	....	.395-3800	
35	10-26-23	.035	2100	2800	3400	....	.395-3800	Same as Nos. 33-34.
		.036	2150	2800	3400	3900	.400-3900	This strip was not roller leveled.
		.035	2050	2700	3350	3850	.405-4000	
36	10-26-23	.0345	2100	2800	3400	3900	.405-4000	Same as Nos. 33-34-35.
		.035	2100	2800	3400	3800	.405-4000	This strip was roller leveled.
		.0345	2200	2850	3400	3950	.400-3950	
41	10-27-23	.0385	2400	3200	3850	....	.365-4000	This strip was not roller leveled.
		.038	2400	3300	3900	....	.375-4200	Stock worked fair.
		.438	2450	3300	3900	....	.365-4100	Breakage 2 per cent.
42	10-27-23	.038	2300	3100	3900	....	.380-4100	Same as No. 41.
		.0385	2250	3200	3900	....	.375-4000	This strip was roller leveled.
		.038	2300	3300	3900	....	.375-4000	
43	10-27-23	.0365	2200	3100	3800	....	.375-4100	Same as Nos. 41-42.
		.037	2300	3200	3900	....	.380-4300	This strip was not roller leveled.
		.037	2200	3200	3950	....	.385-4400	

44	10-27-23	.037	2300	3100	3800	....	.375-4100	Same as Nos. 41-42-43.
		.0375	2500	3300	4000	....	.380-4300	This strip was roller leveled.
		.0375	2500	3250	4000	....	.380-4250	
71	11-14-23	.036	3200	....	....	....	.295-3900	This stock broke badly.
		.035	3200	....	....	....	.285-3800	Breakage 75 per cent.
		.035	3100	....	....	....	.290-3800	
77	11-20-23	.039	2400	3150	3900	....	.385-4200	800 run; breakage 1 per cent.
		.0375	2300	3050	3800	....	.380-4100	
		.0375	2250	3050	3800	....	.385-4200	
90	12-26-23	.038	2100	2800	3400	....	.355-3500	2,300 run; 784 broke.
		.037	2200	2800	3300	....	.355-3450	
		.037	2300	2800	3300	....	.360-3500	
104	1-9-24	.037	2600	3450	4200	....	.360-4400	106 sheets run; 64 broke.
		.0365	2700	3500	4200	....	.360-4400	
		.037	2600	3350	4100	....	.360-4250	
111	1-14-24	.038	2200	3000	3700	....	.355-3900	498 sheets run; 158 broke.
		.0375	2300	3100	3600	....	.360-3800	
		.037	2300	3000	3600	....	.355-3700	
112	1-14-24	.0375	2300	3000	3600	....	.355-3700	
		.0375	2400	3100	3600	....	.355-3700	
		.0375	2400	3150	3700	....	.355-3800	
113	1-14-24	.036	2400	3100	3700	....	.390-4100	1,065 sheets run; 745 stretcher strained.
		.0375	2200	3000	3700	....	.390-4100	
		.0375	2100	2900	3600	....	.390-4000	
121	1-18-24	.038	2500	3300	....	....	.345-3900	Rejected.
		.038	2600	3450	....	....	.345-4000	
		.037	2500	3300	....	....	.340-3900	
122	1-18-24	.036	2100	2800	3400	....	.370-3600	Same as No. 121.
		.036	2150	2900	3400	....	.360-3500	This strip from end of sheet.
		.0355	2100	2900	3400	....	.355-3500	
123	1-18-24	.0365	2300	3100	....	....	.325-3500	Same as Nos. 121-122.
		.0365	2300	3100	3800	....	.365-4000	This strip from end of sheet.
		.0365	2300	3100	3600	....	.350-3600	
146	2-18-24	.038	2350	3400	4000	....	.375-4300	Same as No. 145.
		.039	2300	3400	4100	....	.380-4450	
		.039	2400	3400	4100	....	.375-4300	
153	3-3-24	.035	2050	2700	3200	....	.360-3500	800 run; 44 broke.
		.036	2100	2700	3200	....	.360-3400	
		.036	2050	2650	3100	....	.360-3400	
154	3-3-24	.036	2100	2700	3100	....	.355-3250	Same as No. 153.
		.037	2000	2650	3200	....	.360-3400	
		.037	2000	2650	3200	....	.360-3500	
156	3-5-24	.036	2400	3200	3800	....	.380-4200	796 run; 8 broke.
		.037	2450	3200	3800	....	.380-4200	No strains.
		.036	2400	3200	3800	....	.375-4100	
157	3-5-24	.0365	2400	3200	3850	....	.385-4300	Same as No. 156.
		.037	2400	3100	3800	....	.385-4250	
		.037	2400	3200	3750	....	.385-4300	
170	3-21-24	.035	2200	2900	3400	....	.365-3700	525 run; 131 broke.
		.0365	2100	2800	3400	....	.370-3800	
		.037	2100	2800	3400	....	.375-3900	
184	4-4-24	.0375	2600	3400	4100	....	.380-4400	1,908 run; 51 broke.
		.038	2600	3400	4200	....	.385-4600	1,908 strains.
		.0375	2500	3300	4100	....	.380-4500	
233	5-9-	.035	2300	3200	....	....	.330-3500	Run 420; broke 118.
		.035	2600	3400	....	....	.335-3800	Rejected and returned.
		.035	2300	3200	....	....	.340-3800	
234	5-9-	.036	2400	3200	....	....	.335-3600	Same as No. 233.
		.0365	2600	3400	....	....	.345-4200	
		.0365	2500	3300	....	....	.325-3400	
257	7-24-	.038	2400	3200	3800	....	.380-4200	Run 900; broke 11.
		.038	2400	3200	3800	....	.375-4100	Strains 0; not roller leveled.
		.037	2300	3100	3800	....	.375-4000	

258	7-24-	.038	2400	3300	3900	....	.375-4200	Same as No. 257.
		.038	2400	3300	4000	....	.375-4200	
		.038	2300	3200	3800	....	.380-4300	
279	9-11-	.038	2300	3100	3600	....	.385-4100	Run 2,010; broke 11.
		.038	2300	3100	3600	....	.390-4100	Strains 34; passable.
		.038	2100	3000	3600	....	.350-3700	Roller leveled 2 passes.

TABLE III

Test No.	Date	Thickness	.250	.300	.350	.400	Broke	REMARKS
282	9-18-	.035	2000	2600	....	....	.345-2900	Run 1,020; broke 0.
		.035	2200	2800	....	....	.340-3000	Strains 0; not roller leveled.
		.035	2200	2900	....	....	.340-3000	
283	9-18-	.035	2100	2700	....	....	.345-3200	Same as No. 282.
		.0345	2100	2800	....	....	.345-3200	
		.0345	2100	2800	....	....	.350-3300	
261	8-30-	.038	2000	2900	3400	....	.365-3700	Run 3,600; broke 0.
		.037	1900	2800	3600	....	.375-4100	Strains 750; roller leveled 2.
		.037	1900	2800	3600	....	.375-4200	
262	8-30-	.036	2000	2600	3200	....	.385-3800	Same as No. 261.
		.037	2000	2900	3500	....	.380-4000	
		.036	2000	3000	3600	....	.380-4000	

TABLE IV

Test No.	Date	Thickness	.250	.300	.350	.400	Broke	REMARKS
49	10-29-23	.0345	1900	2500	3100	....	.350-3100	Worked well.
		.034	1900	2550	3150	....	.350-3150	No breakage.
		.034	1950	2600	3000	....	.355-3150	
73	11-16-23	.038	2400	3250	4000	....	.370-4250	Worked well.
		.037	2400	3200	4000	....	.375-4400	No breakage.
		.037	2400	3250	4000	....	.375-4400	No strains.
78	11-23-23	.039	2300	3300	4200	....	.375-4450	No breakage.
		.040	2400	3250	4100	....	.375-4400	No strains after roller leveling.
		.039	2300	3200	4100	....	.380-4600	
85	12-4-23	.036	2300	3100	3800	....	.375-4100	No breakage.
		.037	2300	3100	3800	....	.380-4200	No strains after roller leveling.
		.036	2250	3050	3750	....	.375-4050	
125	1-22-24	.0355	2300	3100	....	....	.340-3700	1,950 run.
		.0365	2350	3150	....	....	.340-3700	Breakage one-half of 1 per cent.
		.035	2300	3050	....	....	.340-3600	
126	1-24-24	.035	2600	3350	....	....	.325-3800	No breakage.
		.035	2600	3400	....	....	.325-3800	No strains after roller leveling.
		.035	2600	3300	....	....	.325-3700	
129	1-24-24	.035	2300	3000	....	....	.345-3500	1,600 run.
		.0345	2200	2900	3550	....	.350-3550	No breakage.
		.0345	2300	3000	....	....	.345-3500	O.K. after roller leveling.
130	1-24-24	.0365	2500	3200	....	....	.330-3600	Run 185; broke 22.
		.0365	2500	3200	....	....	.330-3600	Strains 0; rejected.
		.037	2400	3200	....	....	.335-3600	
162	3-7-	.035	2200	3000	3800	....	.390-4100	Run 1,200.
		.035	2200	3000	3750	....	.385-4000	Strains 725.
		.035	2200	3000	3700	....	.390-4200	Not passable.

condition for japanning. Obviously some work must be done on seconds (sanding, polishing or grinding). The basis used in inspecting and using seconds varies with the purchaser and is usually one of the following:

(a) Keep all seconds separate, using them as substitutes for single pickle or deoxidized sheets.

(b) Handle them with primes, putting on the necessary work to make them passable.

(c) Inspect, mark and cut out the acceptable parts and use the balance as single pickle material.

(a) and (c) have the disadvantage of continually throwing the stock records out of adjustment by making substitutions necessary. (c) is probably the most economical; (b) requires a special layout and considerable equipment.

Seconds in all cases should came from the same heat of steel as the primes which they accompany and should be of the same temper.

Finishes for Automotive Sheets.

In the automotive trade it was customary to use a hard, glossy finished sheet for parts that were to be japanned. A softer, duller finished sheet was used for painted parts. Cold rolled strip has recently been specified to a considerable extent for high finished parts where a considerable depth of draw is required and where it comes within the width that can be rolled as on the fenders of various types.

In the manufacture of the greater widths of cold rolled strip required for fenders the defect known as "cross wrinkes" is probably the most common one and is a sufficient ground for rejection. These may be seen with an average surface inspection upon receipt from mills and cause an excessive amount of work if sheets containing them are processed.

The selection of the proper material for parts whose surface requirements are not so stringent usually depends upon the method of processing. Deoxidized sheets are somewhat cheaper than single pickled stock, but has the disadvantage of carrying small amounts of scale at times. In plants where spot welding is carried on extensively the rejects from bad welds are liable to run high. As a rule if a large piece of full finish material is to be spot welded to deoxidized material, the single pickle stock should be specified, as otherwise the scrap loss or cost of salvaging is liable to run very high occasionally.

It can readily be understood that the inspection for a so-called "two coat job" must necessarily be closer than for a three or four coat job. Where the layout calls for grinding, several classes of defects are cared for automatically. Parts painted or finished in some other manner where a primer is used need not receive the close inspection necessary for a two coat job.

A very important factor which should be considered before the adoption of any schedule or specifications for finish is the life which can be expected from the finished product. If additional coats are merely for the purpose of covering defects it is apparent that it would be advisable to first secure material with a better surface finish. This is especially true as the application of additional coats produces extra hazards and the life is not increased. The adoption of the many different schedules which are in use has resulted largely from other considerations than the protection and original finish of the material. Parts which are to be finished by nickel plating must have a reasonably good surface if the costs are to be held within reason.

Testing for Drawing Qualities.

The testing of sheet or strip steel for so-called "temper" or drawing quality provides a very interesting problem, but is one which offers exceptional rewards for careful work.

The Shore scleroscope was formerly used to a large extent in strip mills, and the hardness figures were a guide as to what could be expected under ordinary conditions.

The Brinell machine is frequently used on heavy gauge material. Variation in gauge, however, influences the readings to such an extent that on single samples they are of doubtful value unless carefully checked for the thickness. Piling the samples gives better readings, but the practice is open to some criticism.

The Rockwell hardness testing machine has some advantages over the above. None of these machines, however, can be used alone and give more than a vague idea of what may be expected.

The Standard tensile testing machine is undoubtedly of great value. In the average plant, however, the cost of obtaining samples is very high and considerable delay is necessary, as the test pieces must be prepared and pulled very carefully.

Ericksen Ductility Test.

The Erichsen ductility machine and Olsen ductility machines have many advantages and will give a good idea of what may be expected. Besides showing the depth of draw at breakage, an examination of the "cup" gives valuable information as to the grain size and what may be expected of the material when used in the press. By a careful comparison of a stamping showing the so-called "orange peel" effect with cups drawn to various depth a remarkable approximation may be arrived at as to the comparative depth of each draw. In making a test of this character it is usually advisable to use sample sheets of comparatively large grain size for obvious reasons.

Definite standards may be established for each job by a careful check of samples over a period of time, taking the depth of draw on one of these machines and comparing these results with the results obtained by running the material on the presses and noting the breakage. Sample pages of typical results are given in Tables I, II, III and IV, which show the limits on these jobs very conclusively.

Olsen Ductility Test.

The Olsen ductility machine has the added feature of showing the pressure required to make a cup of any given depth. By using some standard depth such as .250 in., a remarkably close check on hardness values is obtained between this and results obtained with the scleroscope, Brinell or Rockwell machines. A comparative hardness reading may be conveniently reported by dividing the gauge reading by the thickness. This will take care of all ordinary variations in gauges and is very valuable in many cases. For example, a sample may show excellent grain structure and good depth on the ductility machine, but high hardness values. Such material may show a very high breakage, especially so if used on a fast press or with new dies. Where material for a job is purchased from one mill only and given the same routing, the hardness figures are indicative to a certain degree of the extent to which stretcher strains may develop.

Samples for Ductility Test.

In order to obtain samples of sheet for the ductility test it is customary to take a strip three inches wide, three inches in from each end of the sheet, and also a three-inch strip through the center. On each of these three strips a test is made about six inches from each end and one in the center, making nine tests in all. This will usually show any lack of unformity, if it exists. Samples are usually taken from each end of a cold rolled strip and three tests made on each if the width permits.

It has been noted that all tests on cold rolled strip steel will as a rule show fairly uniform results, but in a shipment there may be a considerable percentage of material which tests and acts entirely different. The tests of sheets show a greater lack of unformity on the single sheet, but the shipments as a rule run reasonably uniform.

Whether cold rolled strip or full finished sheets should be specified for a particular job usually depends on local conditions. Unless special routing is given to extra deep drawing sheets they tend to roughen or "orange peel" on excessive draws. Strip does not tend to do this to such an extent as the stock is usually harder and of finer grain. The price usually equalizes on extra deep drawing grades.

Blue annealed sheets in the heavy gauges may be tested for depth of draw and hardness by using a special fixture on a standard tension machine. It is very difficult to keep the pressure gauges on the standard older type ductility machines in order. The new Olsen ductility fixture is used on a small hand power tension machine to great advantage and especially where it is necessary to duplicate results. This overcomes the greatest objection to the standard ductility machine as now manufactured.

Gauge and Size Tolerances.

The problem of gauge and size tolerances has been studied carefully. Tables V, VI and VII show the specifications covering this phase of the work.

The field of the microscope as an aid to inspection is enlarging gradually. It is very necessary that micro-structure be linked with actual results from the press before definite conclusions can be drawn. The great advantage of the ductility machines over the microscope is ease with which the test pieces may be obtained and prepared, the quickness of performing the test itself and the fact that the results give a better idea of the average run of stock and what may be expected from it. The preparation of the micro-section is often very laborious and the experience of a technically trained man is demanded in order that proper conclusions may be drawn. This judgment is necessarily based upon a close examination of a very small surface.

The microscope can well be called upon to explain the peculiarities which develop with other tests, but where the cause cannot otherwise be ascertained. Just as various stamping plants have been able to determine the correct temper to specify by carefully checking the ductility and hardness tests against the breakage and condition of surface from the presses, so the mills can check the micro-structures obtained

TABLE V—DIMENSION TOLERANCES ON HOT ROLLED STRIP STEEL

THICKNESS B. W. Ga.	AT EDGE		ADDITIONAL AT CENTER
24 to 21 inclusive	—up to 3½ inches wide inclusive	plus or minus .003	plus .001
	—over 3½ inches wide	plus or minus .003	plus .002
20 to 18 inclusive	—up to 3½ inches wide inclusive	plus or minus .004	plus .0015
	—over 3½ inches wide	plus or minus .004	plus .0025
17 to 14 inclusive	—up to 3½ inches wide inclusive	plus or minus .004	plus .002
	—3½ to 7½ inches wide inclusive	plus or minus .005	plus .003
	—over 7½ inches wide	plus or minus .006	plus .004
13 to 11 inclusive	—up to 3½ inches wide inclusive	plus or minus .005	plus .002
	—3½ to 7½ inches wide inclusive	plus or minus .006	plus .003
	—over 7½ inches wide	plus or minus .006	plus .004
10 and over	—up to 3½ inches wide inclusive	plus or minus .005	plus .002
	—3½ to 7½ inches wide inclusive	plus or minus .006	plus .004
	—7½ inches wide	plus or minus .007	plus .005
WIDTH			
	—up to 2 inches wide inclusive	plus or minus 1/32	
	—2 to 5 inches wide inclusive	plus or minus 1/16	
	—5 to 10 inches wide inclusive	plus or minus 3/32	
	—over 10 inches wide inclusive	plus or minus ⅛	

TABLE VI—DIMENSION TOLERANCES ON COLD ROLLED STRIP STEEL

THICKNESS B. W. Ga.	AT EDGE		ADDITIONAL AT CENTER
24 to 21 inclusive	—up to 6 inches wide inclusive	plus or minus .002	plus .0015
	—over 6 inches wide	plus or minus .002	plus .002
20 to 15 inclusive	—up to 6 inches wide inclusive	plus or minus .002	plus .002
	—over 6 inches wide	plus or minus .003	plus .002
14 and over	—up to 6 inches wide inclusive	plus or minus .0025	plus .002
	—over 6 inches wide	plus or minus .004	plus .0025
WIDTH			
	—up to 5½ inches wide inclusive	plus or minus 3/64	
	—5½ to 12 inches wide inclusive	plus or minus 5/64	
	—12 to 16 inches wide inclusive	plus or minus 3/32	

TABLE VII—DIMENSION TOLERANCES FOR SHEET STEEL

THICKNESS U. S. S. Ga.	⅜" FROM EDGE	ADDITIONAL AT CENTER
24 to 19 inclusive	plus or minus .003	plus .0025
18	plus or minus .004	plus .003
17 and 16	plus or minus .005	plus .004
15 and 14	plus or minus .007	plus .006
13 and 12	plus or minus .008	plus .007
11 and over	plus or minus .010	plus .008

WIDTH

Minus 0 or plus ⅜ in.

LENGTH

Minus 0 or plus 2 per cent

by processing in different ways against the ductility and hardness tests and real improvement can be made.

Probably the most important single element leading to the improvement of any product or process is to have a quick sure test while all facts relative to its production are still fresh in the minds of the operator.

The results obtained from ductility testing rechecked with breakage when given to the various mills, have resulted in improvements which were not thought possible both in uniformity and comprehension of the properties desired. At present it seems to offer the best means of giving necessary information to the mills regarding the nature of material required. A number of results of ductility tests are shown in Tables I, II, III and IV. These are from material for four separate parts and are practically self explanatory.

Table I was originally thought to demand extra deep drawing material. From the tests it was determined that a regular grade was much more satisfactory as it was less subject to stretcher strains and there was no breakage when it came within the limits specified.

The same conditions existed with Table III as with Table I.

Table IV was likewise thought to be an extra deep drawing job. An examination of the tests will show what is needed.

A close examination of the tests of Table II is very interesting. There is no question but that this is a very difficult job and exceptional care is necessary in the manufacture of the stock.

Observations on Phosphorus in Wrought Iron

Wrought iron has been an important structural material for many centuries. Even today, in spite of the keen competition with steel, there are many purposes for which it is preferred to steel by engineers. The dearth of reliable published information on the properties of wrought iron from the viewpoint of modern metallurgy is surprising. An investigation recently completed by Messrs. H. S. Rawdon and Samuel Epstein of the Bureau of Standards, Department of Commerce, had for its purpose the study of the effect of phosphorus, one of the ever-present impurities in wrought iron, upon the properties of the finished iron as made by different puddling processes. Recently mechanical puddling processes have been advocated and used to a considerable extent in the manufacture of wrought iron to replace the time-honored hand puddling method, on account of the high labor costs the use of the latter necessarily entails. Very little has been published on the properties of the wrought iron made by these newer processes.

Phosphorus in wrought iron is usualy regarded with some concern since it embrittles the iron, that is, makes it "cold short." The phosphorus is contained in both the iron matrix and the slag threads to which the wrought iron owes its characteristic "fibre." Only the phosphorus in the iron matrix, however, affects the properties of the metal. Mechanical puddling appears to be more effective in reducing the phosphorus content to a lower figure than in hand puddling. Experiments were carried out on wrought iron made by each of the two methods on a "split" heat of pig iron, the two parts of the heat being refined by the two processes, hand and mechanical puddling, respectively. For certain purposes, such as drill pipe for which a "stiff" material is needed, a certain percentage of phosphorus in the iron is desirable. The amount, in such a case, is usually considerably higher than that in good quality bar iron for which the total phosphorus ought not to exceed very much 0.15 per cent.

The investigation was not extensive enough to warrant any sweeping conclusion concerning all the merits of wrought iron made by the two processes. However, nothing was noted which would show that wrought iron made by hand puddling cannot be equalled by mechanical puddling if properly carried out.

Unusual Fossil Uncovered

A fossil of a tree branch, described as one of the finest specimens yet uncovered and said to be more than 100,000,000 years old, has been found by workmen in the Harmar Mine of the Consumer Mining Company at Harmarville, Pa., and is now on exhibition in the Deportment of Mining at the Carnegie Institute of Technology. Through the efforts of George Gehres, general superintendent of the mine, the fossil has been presented to the Department of Mines of Carnegie Tech, on behalf of Isaac M. Scott, President of the Wheeling Steel Corporation.

This unusual fossil was discovered by a crew of miners while taking down slate in one of the entries of the Harmar mine. The specimen, according to Dr. Charles R. Fettke, Professor of Geology, and Edward Steidle, Supervisor of the Co-operative Mining Courses, is a Lepidodendron Lanceolatum, which is one of the principal plants forming important coal deposits. It grew, they say, during the Pennsylvanian period of the Carboniferous more than a 100,000,000 years ago.

The fossil represents the top of a tree and stands about four feet high, the branches having a spread of about three feet. The main branch is about two inches thick at the butt, and in its present carbonized form is almost as thin as paper. The Carnegie professors describe it as a good example illustrating the great amount of plant and vegetable matter necessary to form a single bed of coal six feet thick.

The woody part of the fossil is carbonized. In other words, it has turned to coal. The uniqueness of this remarkable find lies in the fact, officials of the department point out, that the specimen shows so many details such as bark markings, limbs, twigs, and leaves.

In the opinion of David White, chairman of the Division of Geology of the National Research Council who is considered an authority on carboniferous plant, the fossil at Carnegie Tech is one of the finest of its kind that has yet been uncovered. Although it is not uncommon to turn up carbonized fossils showing twigs, butts, and other parts of trees in mines, it is rare, it is said, that a specimen showing any details of growth, is produced.

The fossil has been properly treated to prevent air slacking and is mounted in the geological laboratory for its special value in teaching the geology of coal as well as a permanent exhibit.

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Commutation Troubles in D. C. Machinery

Brush and Commutation Currents Are Vital Influences on Sparking—Elimination of Sparking Requires Knowledge of Many Factors Influencing These Currents

By EARL B. STAVELY*

THE first article of this series discussed the symptoms associated with certain causes of sparking in d.c. motors and generators. It was shown that a careful study and analysis of these symptoms usually provides information which is of great assistance in eliminating commutation troubles. The discussion of commutation troubles will be continued in the present article.

Part II of a series of articles on commutation troubles, their causes and symptoms, and the maintenance of brushes and commutators.

Properties of Brushes.

Certain natural properties of carbon brushes, and of the contact between a carbon brush and the commutator, are related very closely to commutation problems. Commutation conditions are frequently made worse, when attempting to eliminate sparking, by failing to give these properties careful consideration. Since a knowledge of these properties is quite helpful in the solution of commutation problems the more important of these will be described briefly as follows:

1—The electrical resistance of the contact between a carbon brush and the commutator decreases as the brush pressure is increased. The contact resistance for given type of brush with a pressure of two pounds per square inch of contact area will be considerably less, for example, than the resistance with a pressure of one pound per square inch.

2—The electrical resistance of the contact decreases as the current density at the contact increases. The contact resistance for a given type of brush with a current density of 40 amperes per square inch of contact will be considerably less, for example, than the resistance with a current density of 30 amperes per square inch.

3—The resistance of the contact decreases as the temperature of the brush increases. This is true, however, only up to the point where the brush becomes very hot and starts to glow—under this condition the contact resistance increases rapidly as the brush becomes hotter.

4—The resistance of the brush itself decreases as its temperature increases. Carbon differs in this respect from metals.

These properties will be referred to from time to time in this series of articles. One specific way in which they affect commutation conditions will be discussed here.

Unequal Brush Currents.

In machines having two or more brushes per stud sparking frequently occurs at one brush of one stud while no sparking is evident at other brushes of the same stud.

Under ideal conditions the total current per stud will divide equally between the brushes on that stud. With two brushes per stud, each brush will carry one half the total current as indicated in Fig. 1-a. It is impossible, of course, to maintain such ideal conditions.

Suppose now, for example, that the resistance of one of these brushes and its contact becomes less than that of the other brush. Higher pressure on one brush than on the other may be the cause of this inequality of resistance. The two brushes being in parallel, the total current will divide inversely proportional to the brush resistances, that is, the brush offering the lower resistance will carry more than its share of the total current. This condition is illustrated in Fig. 1-b.

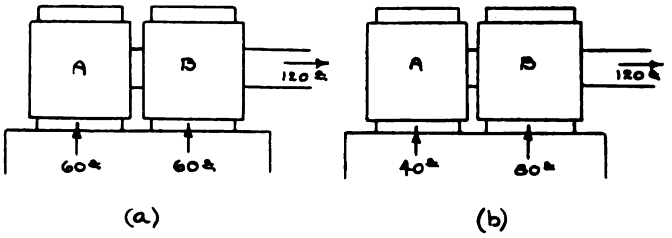

FIG. 1—(a) Equal current distribution between brushes on same stud—the ideal condition of operation. (b) Unequal current distribution. Sparking will occur at oue brush if currents are badly unbalanced.

If the contact area per brush in the example shown by Fig. 1 is 2 sq. in., the current density at the contact of brush B under the unbalanced current condition will be equal to 40 amperes per sq. in., while the density at A will be 20 amperes per sq. in. The contact resistance of B will, therefore, be further decreased (refer to property 2 in the preceding section), while the contact resistance of A will increase. If the density at B becomes too high sparking will occur at that brush, but no sparking will occur at brush A.

It will be evident at once that we are dealing here with causes of sparking which are cumulative in their effects. A comparatively slight initial unbalance in the brush currents will lead to an unbalance in the contact resistances, which in turn will cause a further unbalance in the brush currents. If sparking and heating occurs at brush B in our example, the resistance offered by B will still further decrease, and this will unbalance the brush currents still more. This will tend to make the sparking worse, and so on. For these reasons care should be taken to maintain, in so far as is possible, a practically equal current distribution between brushes on the same end.

With brush contacts in good condition, the initial inequality of brush currents results frequently from unequal brush pressures. The spring tension should be carefully adjusted when new brushes are placed in a machine, and also at intervals during the life of the brushes. The brush pressure can be easily determined by the use of a small spring balance or scales. The scales should be hooked, in this case, to the brush itself and not to the spring of the holder since the friction between different brushes and their holders usually differs quite considerably.

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The brush pressure giving the best all round results depends upon the character of the brush material and the service in which the machine is used. The recommendations of the brush manufacturer must, therefore, be followed closely if the most satisfactory results are to be expected. This at once becomes evident when we note that the recommendations of the brush manufacturer may call for pressures varying from ½ to 6 or 7 lb. per sq. in., the pressure recommended being determined by the grade of brush under consideration and the conditions under which it is applied.

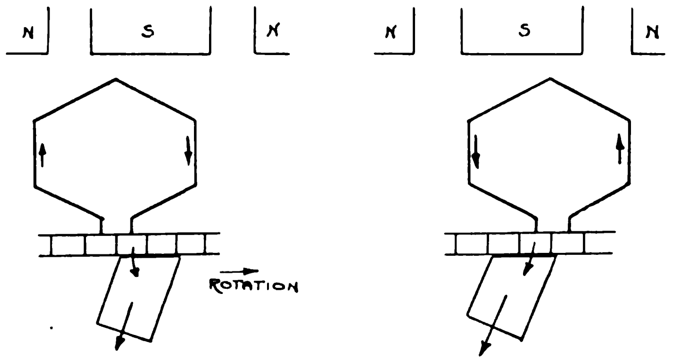

FIG. 2—Reversal of current in armature coil as its commutator bars pass a brush.

Inequality of brush currents frequently leads to a wearing away of the brushes which is so rapid that frequent renewals are found necessary. In the example previously considered, the sparking at brush B may, in a short time, badly burn the face of this brush. The contact resistance at this brush then increases, becoming greater as the condition of the brush face becomes worse. As a result of this the resistance offered by brush A will be less than that of B and A will carry more than its share of the current. We now have the conditions reversed, the effects at A becoming cumulative and eventually causing sparking at A while the sparking at B disappears. Brush A will then be burned away, while the burned face of B will be worn away by the commutator and this brush will again be found in good condition. In a short time, therefore, the resistance at B may again become less than that at A and the conditions will again be reversed. This phenomena repeats itself, following a cycle of events as just outlined, one brush sparking for a time, then the other brush sparking for a time, and so on.

A varying amount of sparking at brushes of the same stud is a symptom which suggests unequal current distribution between the brushes of that stud. The initial cause of this current unbalance may be any one of a number of factors which effect the resistance of the brush contacts—varying brush pressure, condition of brush face, overheating of one brush, brushes sticking in holders, etc.

Commutation Currents.

A group of causes of sparking are associated with excessive commutation currents. These causes of trouble are among those which are usually most difficult to eliminate, hence the subject of commutation currents will be discussed before proceeding further. Reference must be made here to certain of the fundamental principles of commutation but the discussion will be made as simple as is possible.

As a coil passes from the influence of a pole of one polarity to that of a pole of the opposite polarity, the direction of the voltage induced in that coil reverses. A d.c., rather than an a.c., is obtained from a d.c. generator, however, by reversing the connection of each armature coil to the line at the same time that the direction of its induced voltage reverses, these two reversals neutralizing each other. One function of the brushes and commutator is to bring about this reversal of coil connection to the line. During the time required for a commutator bar to pass a brush the current in an armature coil must be completely reversed as indicated in Fig. 2.

The time during which this reversal of current in a coil occurs is commonly called the "time of commutation" or the "period of commutation." During this period the coil is short circuited by the brush since, as shown in Fig. 3, the brush is in contact with the commutator bars to which the leads of this coil are connected. A local path for circulating currents inside the winding is thus provided as shown in Fig. 3.

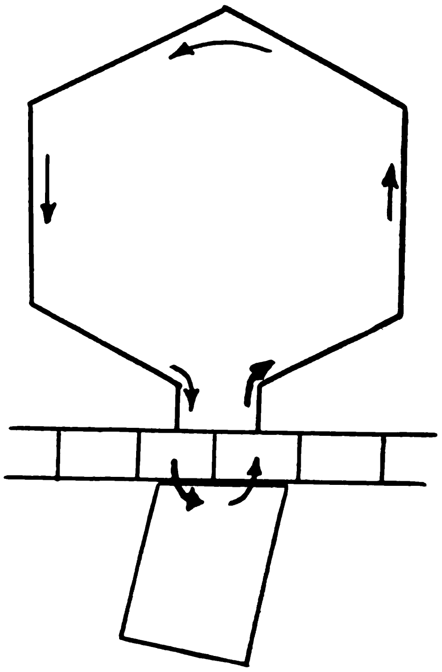

FIG. 3—Short circuiting of armature coil by brush. Path of commutation current shown by arrows.

A current circulating in this local path is called a commutation current. Excessive commutation currents produce various sparking troubles which will be described later.

Ideal Commutation.

As the bars to which a coil is connected move past a brush the area of contact, and therefore the contact resistance, between the brush and each of these bars varies. Due to this varying contact resistance at the two bars the current in the coil would change at a uniform rate, as shown by Curve A in Fig. 4, during its reversal if there were no voltage acting to affect the current change. Perfect commutation is possible under this condition. It is not possible, however, to obtain this condition since there is always a voltage present which affects the change of current—a voltage of self induction.

Voltage of Self Induction.

The armature coils are wound on an iron core hence possess an appreciable amount of inductance. Inductance is a natural property of an electric circuit (just as resistance is a natural property) due to which an opposition is presented to any change of current in the circuit. This opposition is really due to the development, when the current changes value, of a voltage which acts in such direction as to oppose the current change, that is, it tends to maintain the current flow at the same value and in the same direction. This voltage is called the voltage of self induction since it is produced by a change of current conditions in the coil itself rather than by a change in some external condition. Due to this opposing action the reversal of the current is delayed as indicated by Curve B in Fig. 4. If the delaying action is sufficiently great, serious sparking will occur at one edge of the brush.

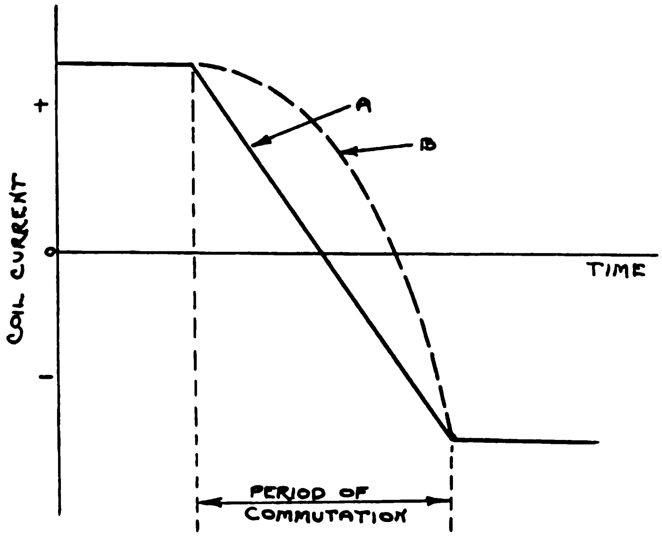

FIG. 4—Curve A shows reversal of coil current under ideal conditions. Curve B shows how voltage of self induction delays the current reversal.

Brush Setting.

In machines without commutating poles the voltage of self induction may be neutralized in part by setting the brushes so that when an armature coil is commutated it will be moving through the fringe of the magnetic field of the pole of the "new" polarity. Under this condition a voltage will be induced in the coil which will be in the "new" direction, that is, in a direction such that it tends to reverse the current in the coil. There are present in the coil, then, two voltages—the voltage of self induction tending to delay the current reversal, and a second voltage tending to reverse the current. These voltages act in opposite directions around the short circuited coil, as indicated in Fig. 5, and if equal will neutralize each other.

The voltage of self induction varies directly with the load. The voltage induced in the coil by its cutting through the magnetic field from the pole varies only slightly as the load varies. For these reasons these two voltages will neutralize each other at only one condition of load with a given setting of the brushes. Ideal commutation conditions can be obtained, therefore, only by shifting the brushes to conform with each change in load, a procedure which is not practicable. The problem is solved in a reasonably satisfactory manner by setting the brushes in a position which gives the best all round conditions of commutation over the normal operating range of loading.

Sparking at no load is sometimes found in machines, a condition which at first thought does not appear to be reasonable. This sparking results from the fact that the brushes have been shifted so far from the neutral that, at no load when the voltage of self induction is zero, an excessive circulating current is produced, in the coils short circuited by the brush, by the voltage induced in those coils by their motion through the main field. When load is put on the machine the sparking disappears, since the voltage of self induction then reduces the value of voltage effective in producing circulating or commutation currents to a point where the currents are not sufficiently large to cause sparking. Under heavy overload the voltage of self induction will become so much greater than the voltage induced in the coil by its motion through the field that the voltage effective in causing circulating currents is sufficient to produce excessive commutation currents in the short circuited coils and sparking again occurs.

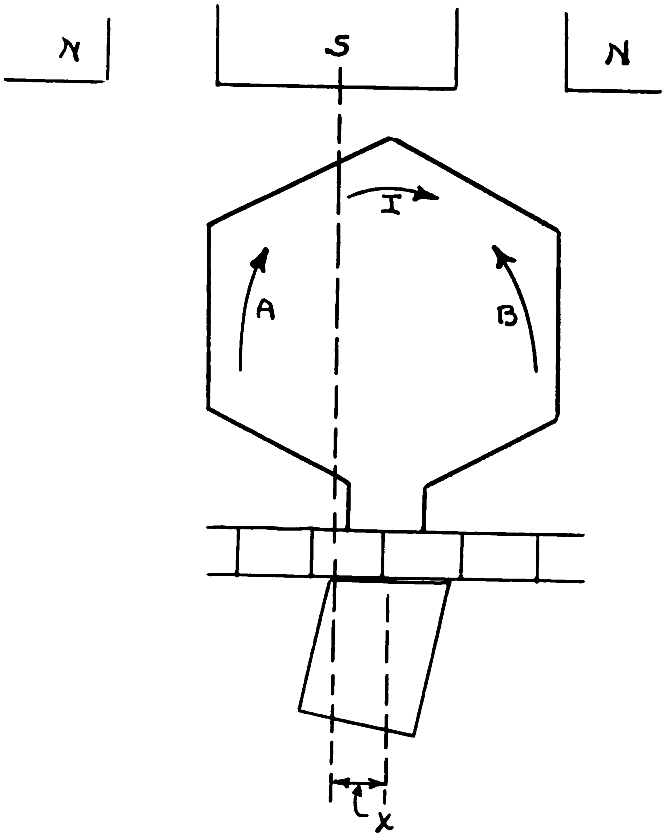

FIG. 5—Brushes shifted through angle X from neutral to improve commutation of machine without commutating poles. I—Direction of current in coil before coil is commutated. A—Direction of voltage of self induction. B—Direction of voltage induced by commutating field.

Commutating Poles.

In machines without commutating poles the brushes are set so that the armature coils will, during the commutation period, be moving through a magnetic field of the "new" polarity, this field really being the fringe of the field produced by the poles of the machine. In commutating pole machines this commutating field, as it is called, is produced by small poles placed midway between the main poles. The exciting coils on these small poles are wound in such direction that their polarity is the same as that of the field in which the armature coils are commutated in machines without these commutating poles. The armature coils in moving through the field produced by these commutating poles have induced in them a voltage which is, therefore, opposite in direction to the voltage of self induction which is caused by change of current in the coils as they are commutated. The exciting coils of the commutating poles carry the load current of the machine, hence their magnetic field, and the voltage induced by that field in the armature coils, varies in direct proportion to the load. Both voltages under consideration varying thus with the load, it is a simple matter to adjust the strength of the commutating poles to give practically ideal commutating conditions at all loads with the brushes set in one fixed position. Excessive commutation currents can thus be avoided; this greatly reduces the possible causes of sparking. Commutating poles cannot, of course, eliminate sparking due to such causes as poor brush contact, chattering of brushes, dirty commutator, high current density at contact due to overload, etc.

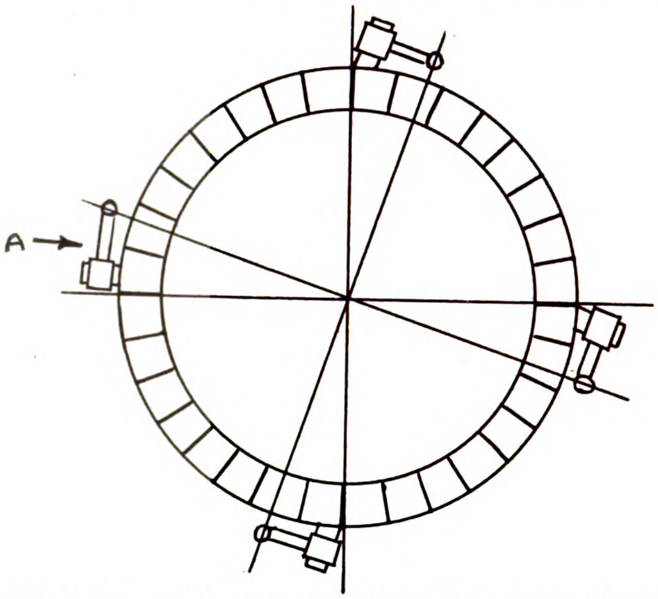

FIG. 6—Unequal brush spacing due to improper setting of holder on Stud A, brush A not being in best position for commutation of coils. Sparking will occur at brush A, but not at other studs.

Unequal Brush Spacing.

One cause of excessive commutation currents will be noted here—unequal brush spacing. Other causes will be considered in a following article.

If the brushes are not equally spaced around the commutator, sparking may occur at one or more studs. This results from the fact that, while some of the brushes may be in the position required to commutate the coils properly, one set of brushes may be in such position that it short circuits armature coils while the voltage of self induction and the voltage produced by the commutating field are not sufficiently well "balanced" to eliminate excessive circulating currents in the short circuited coils.

The spacing of the studs is usually made equal at the factory in connection with the manufacture of the machine. Unequal brush spacing most frequently results, therefore, from improper setting of the brush holders on the studs, a greater "tilt" being given to one brush holder than to the others. This condition is shown in Fig. 6.

The spacing of the brushes may be easily checked by placing a strip of paper around the commutator and under the brushes and making a mark at the toe of each brush. After then removing the paper the distance between marks can be measured; if the distances between adjacent marks are not equal the brushes are not properly spaced. A comparison of these distances will indicate which brush should be changed and in which direction it should be shifted.

Effects of Excessive Commutation Currents.

As shown in Fig. 7-a the load current and the circulating current are in the same direction at one portion of the brush contact and in opposite directions at the other portion of the contact. For this reason a high current density is produced at the portion of the contact where the two currents add, and a lower density results at the other portion where the currents subtract. Sparking due to excessive commutation currents occurs, therefore, over about one half the brush contact and causes a burning of this portion of the brush. The other half of the brush face is left in good condition. The appearance of the brush face in this case is shown in a crude way in Fig. 7-b.

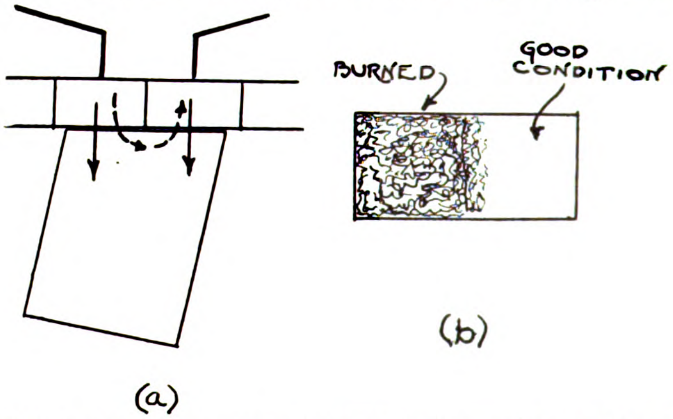

FIG. 7—(a) Heavy arrows indicate load current; dotted arrows indicate commutation current. Note that these currents add at one part of brush and subtract at the other part. (b) Appearance of brush face when sparking occurs due to excessive commutation current.

A brush face found in this condition is a symptom which suggests that the sparking is due to excessive commutation currents. This symptom should not be confused, however, with somewhat similar appearance of the brush face which results from sparking caused by a brush making contact with the commutator only over a portion of its face.

One cause of excessive commutation currents was discussed in the preceding section. Other common causes, and their symptoms, will be considered in the next article of this series.

Cyanid Accumulation in the Blast Furnace[*]

Cyanid Accumulation Has Been Found Sufficient to Account in Vaporization for Over 30 Per Cent of the Coke Burned to Keep the Hearth Hot

By RICHARD FRANCHOT[†]

As everybody knows, the blast furnace is a gas producer. As to the reason for this, people are not so well agreed. The significance of the fact is obvious, for the extent to which the fuel leaves the furnace as combustible gas measures poor economy in iron smelting; while good efficiency in this respect means poor gas. The furnace thus works at cross purposes. The present trend of the steel industry is toward a primary use of the blast furnace as a gas producer with pig iron as a byproduct. Needless to say, this trend is away from improvement in iron making. The production of more and better iron in a given furnace consuming a given amount of coke would seem, at least, to involve a decrease in the relative proportion of the combustible gas. The possibility at the same time, however, of making more and better gas need not necessarily be excluded. (The more the furnace acts as gas producer, the bigger is the sulphur problem.) Whatever the object, it would seem desirable to have a clear, comprehensive, mathematically exact estimate of why and how the blast furnace functions, to the large degree that it now does, as a good producer.

Only Third of Coke Burned to CO_2.

The literature does not give a definite answer to the question. That for which explanation is sought is the fact that only a minor part, usually not more than a third, of the coke carbon burned is oxidized to carbon dioxide; that the development in the furnace of the fuel energy is thus limited usually to little more than 50 per cent; that it requires about twice as much fuel coke to make a ton of iron as is indicated by the relative heat-developing and heat-absorbing values involved; or, conversely, the fact that the production of iron per unit of coke is at best only about one-half that suggested by these heat values. The fact is that in daily operation the ratio of ore burden charged with the coke is limited to about half that which is theoretically possible with 100 per cent conversion of the fuel carbon to carbon dioxide. The fact is to be found set forth in any textbook, the limiting factors have not been formulated with any approach to mathematical exactness. It is fair to assume that the limiting factors are not known.

One widely attempted explanation of the phenomenon is that first offered by Lowthian Bell[1] who took the comfortable view that his furnaces had reached the theoretical limit of efficiency when the top gas contained, as it often actually did, about one-half a volume of CO_2 to one of CO (a ratio of 33 per cent CO_2 to 67 per cent CO) the reducing power of the gas then being, as he assumed, exhausted because of the reversibilty of the reaction between carbon monoxide and iron oxides. This view has been experimentally tested (in the laboratory) by a number of investigators, notably Baur and Glaessner, Boudouard, Schenk *et al.*, Matsubara, Eastman (Journal American Chemical Society (1922), 975). These studies of the equilibrium relations of CO_2 and CO in the presence of iron and its oxides have shown that at temperatures even higher than that of the usual blast furnace top, FeO is reduced to Fe by a gas with a ratio of over 50 per cent CO_2 to less than 50 per cent CO and that hematite and magnetite are reduced to FeO at all furnace temperatures by gases having a much higher CO_2 ratio than 50 per cent. The belief that the high coke ratio (low burden ratio) is to be explained by the necessity of maintaining a 2 to 1 excess of CO at the top of an 80-ft. counter-current system in order to deliver fully reduced iron at the bottom in 10 to 15 hr. would seem to be in need of revision. As a matter of fact it has been experimentally demonstrated that CO can be completely oxidized to CO_2 by iron oxide;[2] and it can readily be shown that the poorest gas known to issue from a blast-furnace top has a reducing action on iron ores. In charcoal furnaces, the CO_2 ratio often goes over 50 per cent.

"Direct Reduction" Is a Misnomer.

Another reason often assigned to the high coke ratio was also first suggested by Lowthian Bell, who opined that CO is incapable of removing all the oxygen from iron ore and that to effect complete reduction to metal the oxide must react directly with carbon, converting it to CO. That this view is not supported by fact is obvious from the generally observed reduction of iron oxide to metallic iron by simple treatment with CO. Quite recently some Bureau of Mines work with an experimental furnace[3] has shown (as has long been evident in charcoal practice) that a furnace can be run without any so-called "direct reduction." That this term is a misnomer is clear from the consideration that it should be impossible to postulate direct contact between iron oxide and solid carbon, for, assuming such contact, the resulting reaction would immediately destroy the contact by causing the solids to be separated by a layer of CO. Then CO_2, formed from CO by reaction with the oxide, at high temperatures reacts with the carbon, forming CO again. The final result is the same, namely the conversion of solid carbon to CO and the reduction of iron oxide to metal; but the reaction progresses indirectly and only confusion results from naming it "direct reduction."

The confusion resulting from this term is exemplified by the attempt on the part of some commentators to draw a distinction[4] between "direct reduction" and "solution loss." Solution loss is sometimes termed "premature combustion" of coke. It refers to the well-defined action by which CO_2 formed in reduction and in the dissociation of limestone gasifies coke with formation of CO and reversion of CO_2 to CO, as expressed in the equation $CO_2 + C = 2\,CO -$ 38,880 calories.

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[*] Presented at the annual convention of the American Institute of Mining and Metallurgical Engineers, New York, February, 1926.

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As far as CO_2 formed in reduction is concerned, this reaction is a component of the action by which iron oxide, in being reduced, converts CO to CO_2 and this CO_2 takes up carbon, the whole result being the same, chemically and thermodynamically, as if iron oxide should react directly with carbon to form CO. As Thomsen says, "The Thermal effect has always the same value, no matter whether the compound is formed directly or by successive stages." So:

$$O + CO = CO_2 + 68{,}040 \text{ cal.}$$
$$CO_2 + C = 2CO - 38{,}880 \text{ cal.}$$

$$\text{Sum:} \quad O + C = CO + 29{,}160 \text{ cal.}$$

Whatever the mechanism of the action, it is fairly obvious that no valid distinction exists between the effect known as solution loss and that of so-called direct reduction. The effect is the gasification of coke by ore oxygen to CO and a greatly lessened development of heat compared with that associated with the oxidation of CO to CO_2. This lessened heat development reflects the heat absorption associated with the reaction between CO_2 and carbon. The solution loss or premature combustion effect is generally recognized as deleterious, variable, and more or less unnecessary. In view of these considerations, it would appear that what has been termed "direct reduction" cannot be regarded as an unavoidably necessary factor limiting the burden ratio, and hence causing a definitive proportion of the coke consumption.

The fact that the coke involved in solution loss forms a substantial part (usually from 10 to 15 per cent) of the coke used in making iron is well established, as is its significance. Gruener's ideal theorem states, in effect, that maximum efficiency is a matter of minimum solution loss. That the gasification of coke by CO_2 from reduction and calcination is an integral part of the mechanism through which the furnace converts a major fraction (about two-thirds) of the fuel carbon to CO is unquestionable. It may therefore be safely assumed that the conditions underlying solution loss will be found to be the conditions primarily responsible for the furnace's acting as a gas producer.

Cause of "Solution Loss."

The cause of solution loss is simple and obvious. The heat absorbed in the gasification of carbon by CO_2, 3,240 lb.-cal. per lb. of carbon gasified, is supplied by the stream of hot gases rising from the hearth. This heat is necessary to maintain the action and is a cause of the effect known as solution loss. The loss is secondary to the primary development of heat by air in the hearth. As a matter of fact, which will be illustrated in detail later, the amount of heat developed by the combustion of air and carbon at the tuyeres is greatly in excess of the amount that can be absorbed in the smelting. The greater part of the heat so developed is carried by the gases into the shaft and the excess heat (relative to work done) raises the temperature of the shaft to such an extent that the CO_2 formed there is enabled to dissolve from the coke an amount of carbon equal to 10 or 15 per cent of the total carbon charged. The action is double-edged in that a like amount of carbon, which otherwise could leave the furnace as CO_2, reverts to CO. This action thus accounts for CO in top gas equivalent to from 20 to 30 per cent of the coke carbon out of a total of perhaps 70 per cent or 30 to 40 per cent of the gas production. The action is entirely analogous to that commonly utilized in the gas-producing art when products of combustion (CO_2) are mixed with the air to act endothermically in increasing the gas yield. As in such a gas producer, so in the blast furnace, the surplus heat from air gasification determines the gasification of carbon by CO_2 and a proportional cooling effect upon the gases. Without the surplus heat carried up in the gas, reduction of ore could proceed exothermically by oxidizing CO to CO_2 without reversion and the CO_2 ratio of the top gas (as it actually is in charcoal practice) could be 45 to 55 per cent instead of 35 per cent as a present maximum. It will be shown later that the surplus heat from air combustion accounts quantitatively for the solution loss which, as has been seen, is intimately involved with the gas-producing function of the furnace.

Is Large Surplus of Heat Necessary?

The question now becomes: Why is a large surplus of heat necessary? Why cannot the burden be increased and more of the heat developed by air be absorbed in heating more iron and slag, calcining more limestone? What are the conditions that limit the burden to that which can absorb only about half of the heat and reducing power (the energy) of the gas produced in the hearth? What is it that primarily determines the amount of iron and slag that can be run through the hearth for a given amount of coke burning to CO with air? Or conversely, what is it that determines the weight of coke that must be burned with air, preheated to the usual blast temperature, in order to maintain the furnace heat against the cooling action (heat absorption) involved in the production of a given amount of iron and its accompanying slag? Taking for granted that it is not the requirement of reducing gas that primarily determines the relative amount of coke burning with air, what then does? What is the primary function of the coke burning with air?

The question almost answers itself. To J. E. Johnson, Jr.[5] belongs the credit for working out the answer by the application of thermodynamic principles. Once pointed out, it becomes obvious in practical operating experience that, primarily, the purpose and result of the combustion of coke with hot air in the hearth are to keep the hearth hot. When the operator adjusts the burden and the blast heat he has in mind, for the moment at least, nothing else but keeping the hearth hot enough to give the desired composition as to silicon and sulphur to the iron he is making. He puts on burden to the maximum consistent with the grade of iron wanted. The primary function of the coke burning with air is to keep the hearth hot against the cooling actions (work done) there. For a given grade of iron, the burden is determined by the quantity of heat available for work in the hearth. The hearth is the focus of attention. As Johnson[6] states: "To keep the furnace hot enough in the hearth to run, a certain amount of fuel must be burned in the hearth for every unit of iron produced, the amount having nothing to do with reduction or, in a general way, with chemistry at all, but being a plain matter of heat, as in the case of melting ice or any other solid." It may be put down as the major premise of furnace operation that the burden is primarily limited by a lack of available heat in the hearth.

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"Critical Temperature" Defined.

As defined by Johnson, the available heat is measured by the speed between the theoretical combustion temperature and the "critical temperature" to which the iron and slag have to be heated. According to Johnson, this temperature is determined by the free-running property of the slag. It is not necessary to use the word "critical" in the same sense as when used, for example, in connection with the melting of ice where the temperature remains stationary. It is sufficient to say that the heat available at any temperature is the difference between the total combustion heat and that carried by the products of the combustion at that temperature. By the law of conservation of energy (first law of thermodynamics) the heat available at the temperature at which it is necessary to maintain the hearth is equal to the heat absorbed in work done in the hearth. With known data on specific heats and the heat of formation of CO, such as are given in Richard's Metallurgical Calculations, it is a simple matter to calculate the available heat for the observed temperature and hence to measure the total work done or heat absorbed in the hearth, referred to a unit of fuel. Thus, for an average temperature of 1500 deg. C. (2732 deg. F.) indicated by slag, metal, and tuyere observations we have, per pound carbon burning to CO with 5.7 lb. dry air at 600 deg. C. (1112 deg. F. blast heat) expressed in pound-calories (pound centigrade thermal units) the following:

	Calories
CO formation from 1 lb. carbon	2430
1 lb. carbon preheated in shaft to 1500 deg.	650
Blast heat, 5.7 lb. air at 600 deg., 0.25 mean specific heat	855
Total heat developed per pound carbon	3935
6.7 lb. CO and N_2 at 1500 deg	2700
Heat available at 1500 deg	1235

Hence we can say, subject probably to only small error, that the total heat absorbed in the hearth, other than that carried out by the products of combustion, is 1235 cal. (2223 Btu.) for every 5.7 lb. dry air (blast heat 1100 deg. F.) blown in at the tuyeres and converting 1 lb. carbon to CO. We can also say that 1235 cal. per pound carbon burning with air measure the cooling actions taking place in the hearth that hold the temperature down to 1500 deg. C. (2732 deg. F.) when the total heat developed is sufficient, in the absence of such cooling actions, to produce a temperature of 2180 deg. C. (3956 deg. F.).[7] And we can say further that it is in order to supply 1235 cal. per pound carbon to meet the cooling actions taking place in the hearth that the blast heat is set at 1100 deg. F., thereby supplying 855 calories, some 69 per cent of the available heat. The ratio between the pig iron produced and the carbon burning with air being easy to ascertain, we can derive the heat absorption in the hearth per pound of iron. For example, with 1.5 lb. iron per pound carbon burning with air, we can say that for every pound of pig iron produced it is necessary to supply 823 cal. available in the hearth; or that to provide the heat required in the hearth. 0.66 lb. carbon per pound pig iron must be burned with blast at 1100 deg. F. If desirable, the relations can be figured on the basis of time and we can say how much wind must be blown and how much carbon burned per minute in order to supply heat at the rate required to keep the hearth hot. Perhaps yet more significantly this figure, 1235 calories per pound carbon, indicates the maximum theoretical efficiency of the hearth, namely 31 per cent, about 68 per cent (2700 cal.) of the total heat (3935 cal) being carried out in the combustion products. That is to say, in supplying the heat required to be available at 1500 deg. the total heat developed is over three times the hearth heat; and the heat carried into the shaft is double the hearth heat. It is this sensible heat carried up the shaft that causes solution loss and a hot top. The actual efficiency of the hearth is, of course, some fraction of the 31 per cent theoretical maximum, as there are inevitable heat losses, such as by radiation and water cooling, decomposition of blast moisture and, as will be shown, by other actions the importance of which appears not to have been recognized. In the last analysis, it is the net heat over and above these losses that determines the rate at which the iron and slag can run down without adverse effect upon the pig iron analysis. It is the ratio of the net effective heat per pound carbon to the useful smelting work per pound iron remaining to be done when the iron and slag come into the tuyere region that primarily determines the burden ratio. Manifestly it is the appropriation of the hearth heat, the relative proportions thereof absorbed in various cooling actions taking place in the hearth, the relative weights of the individual cooling factors, that tell the real inside story of blast-furnace economy.

Hearth Heat Important.

The question is now, since Johnson's demonstration of the overshadowing importance of the hearth heat, what is the actual efficiency of the hearth as a separate and distinct zone of the furnace? What proportion of the hearth available heat is actually absorbed in useful smelting work connected with the final treatment of metal and slag? How much of this heat goes to balance the unavoidable heat losses in the hearth? How much offsets other cooling actions which have to be taken into the account? Any attempt to estimate the amount of work remaining to be done on metal and slag as they arrive in the tuyere zone must be based to such an extent upon arbitrary assumptions that the estimate will have little value. The cooling effect of iron and slag in the hearth may be arrived at for purposes of illustration by difference after the heat losses and other cooling actions have been estimated. The losses have been mentioned as those due to decomposition of blast moisture and water cooling and radiation. The other cooling action that must be figured in is that which completes the explanation of the furnace action, namely the vaporization of material in the hearth, specifically, the vaporization of accumulated cyanids and that of slag constituents.

Blast humidity observation is an accurate basis for the first loss. The reaction, $H_2O + C = CO + H_2 - 28{,}900$ cal. indicates 1605 lb.-cal. per pound blast moisture as the heat supplied by air combustion. Each grain of humidity per cubic foot of standard dry air, or 0.01 lb. H_2O with the 71 cu. ft. involved in burning a pound of carbon to CO, accounts for 16 cal. To 5 gr. moisture, as illustration, the heat chargeable is 80 calories.

The radiation and water cooling loss in the modern furnace is usually arrived at by difference in the heat balance, and is thus found to run from 600 to 1000 cal.

per pound carbon burning with air. Assuming that half of the average loss takes place below the bosh angle and half of this in the tuyere zone, we probably will be nearly right if we charge off to this item 200 calories.

References.

[1]"Chemical Phenomena of Iron Smelting." Routledge, London, 1872.
[2]See for example "Chemical Phenomena of Iron Smelting," Sec. VIII, page 27.
[3]Royster, Joseph and Kinney, Blast Furnace and Steel Plant, January, 1924.
[4]Walther Mathesius: Proc. American Iron and Steel Institute, May, 1917.
[5]"The Principles, Operation, and Products of the Blast Furnace." McGraw-Hill Book Company, New York.
[6]Op cit. 13.
[7]Richards "Metallurgical Calculations," 308.

(To be continued.)

Protecting Furnace Parts from Oxidation

By Hugh E. Weightman*

Protecting metal surfaces from oxidation by the process of projecting aluminum into the metal with a metal-spraying apparatus has proven to be a commercial success. This process is especially useful in coating iron castings. The process introduces a thin aluminum coating into the metal. The section through the treated metal shows a combination of the iron and aluminum and at the outer skin a pure aluminum-oxide coating is produced. The oxide coating has a melting point of 3,200 deg. F. to 4,000 deg. F. This process will allow the operation of iron at much higher contact temperatures in an oxidizing atmosphere without the consequent loss of unprotected iron.

The disadvantage of the process is the necessity for replacing the coating from time to time. The metal-spraying equipment must be operated by technical labor. In some cases it is impossible to get the apparatus close enough to the iron parts owing to the heat of the furnace, even when not under operation. The latter is the case in heating furnaces used in steel mill practice, using silica brick roof structure. In this case the furnace must never be allowed to cool below a red heat. Door jambs on such furnaces wear out by scaling. In boiler plants the grates and stoker parts in contact with the fuel cannot be conveniently treated with the metal-spraying apparatus.

A new process for treating metal parts of furnaces has been developed by the writer in which no spraying apparatus is needed. The process consists in treating the metals with a slip made of an aluminum-iron-titanium mixture with sodium-metasilicate.

For new parts, the castings are washed in a caustic solution to remove grease, oil and sand; then washed in water; after which the parts are dipped into the above mentioned slip or slurry. The slip dries almost immediately so that the parts may be installed without delay. Where door jambs, grate bars and similar parts are already installed they may be cleaned sufficiently with a steel brush and the slurry painted on with a paint brush or sprayed on with an ordinary paint spray machine.

The addition of an oxide coating on materials while offering many advantages is not a permanent proposition and must be replaced from time to time. For that reason the process which uses only the simplest of tools and admits the widest application will find the widest application.

An application has been made to the fire side of a coal fired rotary dryer used in a powdered fuel installation. The material was applied with a paint brush after having scrubbed the surface slightly with a steel brush to remove large iron oxide scales. This dryer has been in operation for two years with only two coatings. The second coat was applied one month after the first coat as added precaution. The dryer is still in operation without any further signs of scale formation.

Door jambs in a billet heating furnace had always been replaced after three weeks operation owing to a loss by scaling of 20 per cent. Treating the new jambs with this process resulted in the jambs lasting 22 weeks with one application with the same loss. Treating new jambs every week by painting them on Sunday each week has maintained the jambs in perfect condition. These jambs are exposed to considerable heat when the door is down and rapidly cooled when the door is raised for removing or placing a billet.

Treating the grate bars in a hand fired marine boiler not only reduced the wear of the bars by some five fold but prevented the ash from fusing to the bars. This resulted in easier firing conditions. More perfect combustion was realized than was possible under previous conditions.

Monel metal pots were treated with this mixture with a consequent better life in handling. Cast pots for annealing have been treated, and have shown that the pots so treated stand better as regards scaling, cracking and warping.

The process has been used as a protective coating to brick work in heat-treating operations. In this work it made a smooth surface, without the glassy surface, welding the brick into a mass. One clay pot manufacturer's crucibles have been treated in order that they might be used in the melting of monel metal. This has worked with a great deal of success. This has been the only molten metal work in which the process has been tried.

The composition can be conveniently made of Ilmenite and Diaspore or Ilmenite and other high alumina clays or shale. The massive high-alumina shale is superior to the use of aluminum oxide. Alunite can be used after considerable preparation though the potash bearing clays are not as suitable as soda clays. Magnesia should be avoided in any clays used in the process. This is also true of mica bearing minerals. The quantity and type of sodium silicate used will vary with the different minerals used in making the mixture. Care is required in this selection, otherwise the slip will peel from the casting. In any case the slip is applied very thin.

Refractories Institute to Hold Annual Meeting

The annual meeting of the American Refractories Institute will be held in Philadelphia, Pennsylvania, on May 12th, at the Bellevue-Stratford Hotel. Plans are under way to have a number of papers presented by technical and practical men of the industry, and floor discussions of these papers will be invited. In addition, several prominent speakers will be asked to talk on topics of the day. Those who attend the meeting should plan to stay for dinner in the evening. Non-members are invited to attend both the business session and banquet.

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Welding in an Atmosphere of Hydrogen

Exclusion of Air by Hydrogen Prevents the Formation of Oxides and Nitrides in the Weld Metal—Fused Metal Is as Strong and Ductile as the Original Metal

TWO methods for producing ductile welds have been developed by research scientists of the General Electric Company. Both of the methods, similar in some respects, mark a decided step in the utilization of the heat of electric arcs in the joining of metal parts or the building of metal structures. The one was developed in the Schenectady research laboratory by Dr. Irving Langmuir; the other was developed in the Thomson research laboratory at Lynn, Mass., by Peter Alexander.

In both processes, air is excluded from the metal by means of a bath of hydrogen or other gas. The formation of oxides and nitrides in the weld metal is thus prevented, and the fused metal is as strong and ductile as the original metal.

Hydrogen Increases Welding Temperature.

Announcements of these radically new methods of arc welding are made in the March issue of the General Electric Review. In brief, the method developed by Dr. Langmuir in Schenectady is to pass a stream of hydrogen between two electrodes. The heat of the arc breaks up the hydrogen molecules into atoms. These combine again a short distance in front of the arc into molecules of the gas, and in so doing liberate an enormous amount of heat, so that much higher temperatures can be obtained with this than with the usual welding methods. Since atomic hydrogen is a powerful reducing agent, it reduces any oxides which might otherwise form on the surface of the metal. Alloys containing chromium, aluminum, silicon or manganese can thus be welded without fluxes and without surface oxidation.

The process developed in the Lynn laboratory by Mr. Alexander is based on the utilization of the chemical and physical properties of hydrogen and other gases in their molecular state. This process aims primarily at the prevention of the formation of the nitrides and oxides in the arc-deposited metal, which limit the ductility of the usual arc welds.

In this process the arc is struck between the metallic wire or carbon used as one electrode and the plate or work to be welded used as another electrode. The crater of the arc is always on the work to be welded. The gaseous atmosphere is supplied in a form of a stream around the arc. Pure hydrogen, water gas, hydrogen-nitrogen mixtures, anhydrous ammonia, methanol vapor and some other suitable gases can be used, according to the nature of the work. The hydrogen-carbon monoxide mixtures were suggested by Professor Elihu Thomson; water gas and methanol are examples of such mixtures.

This process makes the arc welding process more efficient and suitable for the fields which at present are out of its reach. Low carbon steel, alloy steels, and most of the non-ferrous metals and alloys can be welded with success by this process in suitable gaseous mixtures.

Atomic Hydrogen Arc Welding.

Fifteen years ago, while studying the loss of heat of the tungsten filaments of incandescent lamps in an atmosphere of hydrogen gas, Dr. Irving Langmuir found that at a high temperature the hydrogen gas changed from the molecular to the atomic state. In the molecular state, two atoms of the gas are grouped together as a unit; in the atomic state each atom acts as a unit. The molecular form is the more stable, and when the atoms recombine to form the molecules intense heat is liberated.

Dr. Langmuir's study of the filaments in hydrogen was a theoretical investigation. The results of this investigation have now been applied in a different field—in the development of a new method of welding, by which it is possible to produce welds as strong and as ductile as the original materials.

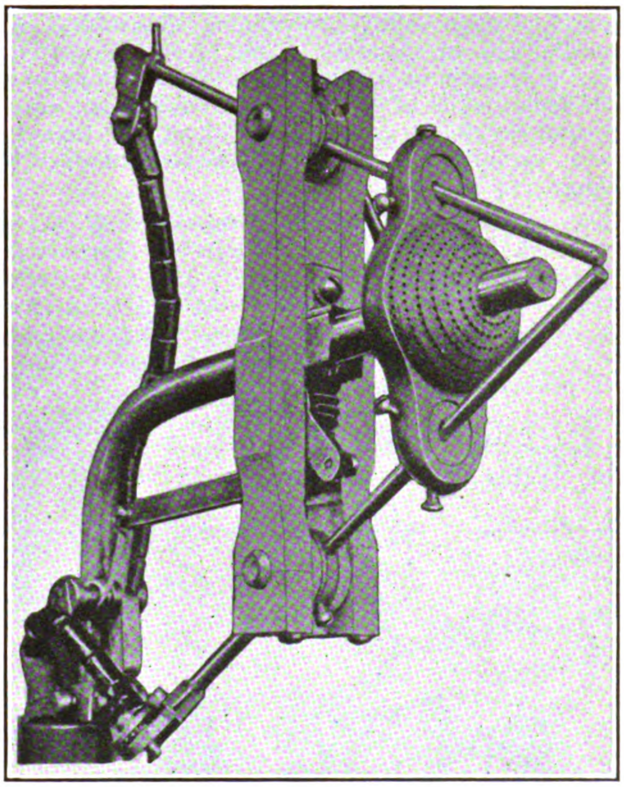

FIG. 1—Atomic hydrogen arc welding torch, type I.

Continuing the theoretical investigation, Dr. Langmuir found that more atomic hydrogen was formed by passing powerful electric arcs between tungsten electrodes at atmospheric pressure. By directing a jet of hydrogen from a small tube into the arc, the atomic hydrogen could be blown out of the arc, forming an intensely hot flame of atomic hydrogen burning to the molecular form and liberating about half again as much heat as does the oxy-hydrogen flame. In this flame molybdenum, one of the most refractory of metals, melts with ease; quartz, however, melts less easily, in spite of its lower melting point. This indicates that the metal assists in the action as a cata-

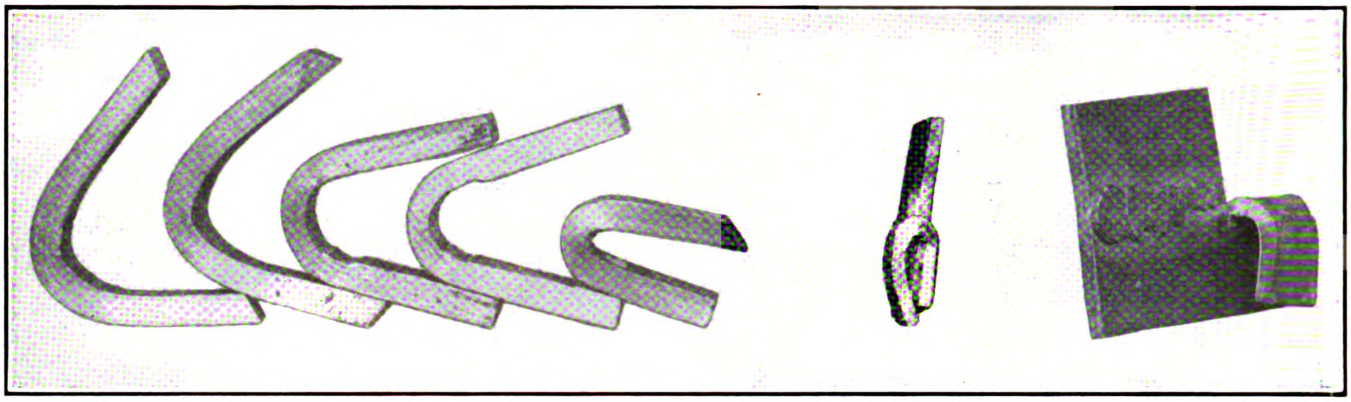

FIG. 2—Transverse bends on samples of arc welds produced with semi-automatic machine in hydrogen atmosphere.

lyzer—which scientists define as a substance which accelerates a chemical change.

Contamination of Weld Eliminated.

By this method, iron can be welded or melted without contamination by carbon, oxygen or nitrogen. Because of the powerful reducing action of the atomic hydrogen, alloys containing chorimum, aluminum, silicon or manganese can be welded without fluxes and without oxidation. The rapidity with which such metals as iron can be melted seems to exceed that in the oxy-acetylene flame, so that the process promises to be particularly valuable for welding.

The technical development of this welding process has been the work of several men in the Schenectady laboratory, including R. A. Weinman and Robert Palmer. These men have developed and tried many types of welding torches, and have tried them under varying conditions. At the same time tests of numerous types of welds have been conducted.

The two electrodes of the torch are tungsten rods, held at an acute angle with each other by lava insulators. When not in use, the electrodes are in contact with each other; they can be separated by pressure on a lever mounted on the handle. A set screw is provided for making slow adjustments of the electrodes. The hydrogen is supplied by a tube through the handle. Sufficient gas is used so that not only are the electrode tips surrounded by enough to form the blast of atomic hydrogen, but by an additional quantity to surround the work with hydrogen.

Either alternating or direct current can be used. The first mentioned has been found more convenient, and electrodes of smaller diameter can be used. The gas pressure required to operate the torch is very small; in the laboratory, with short lengths of tubing, a pressure of less than one pound per square inch was sufficient with metals up to one-half inch in thickness. For ordinary welding, the rate of gas consumption varies between 20 and 30 cubic feet per hour.

Since the maximum rate of heating is desired in welding, the torch is held close to the metal. Best results have also been obtained when the torch is inclined so that the blast of hydrogen from the torch passes over the pool of molten metal in a direction opposite to that in which the torch is moved along the line of the weld.

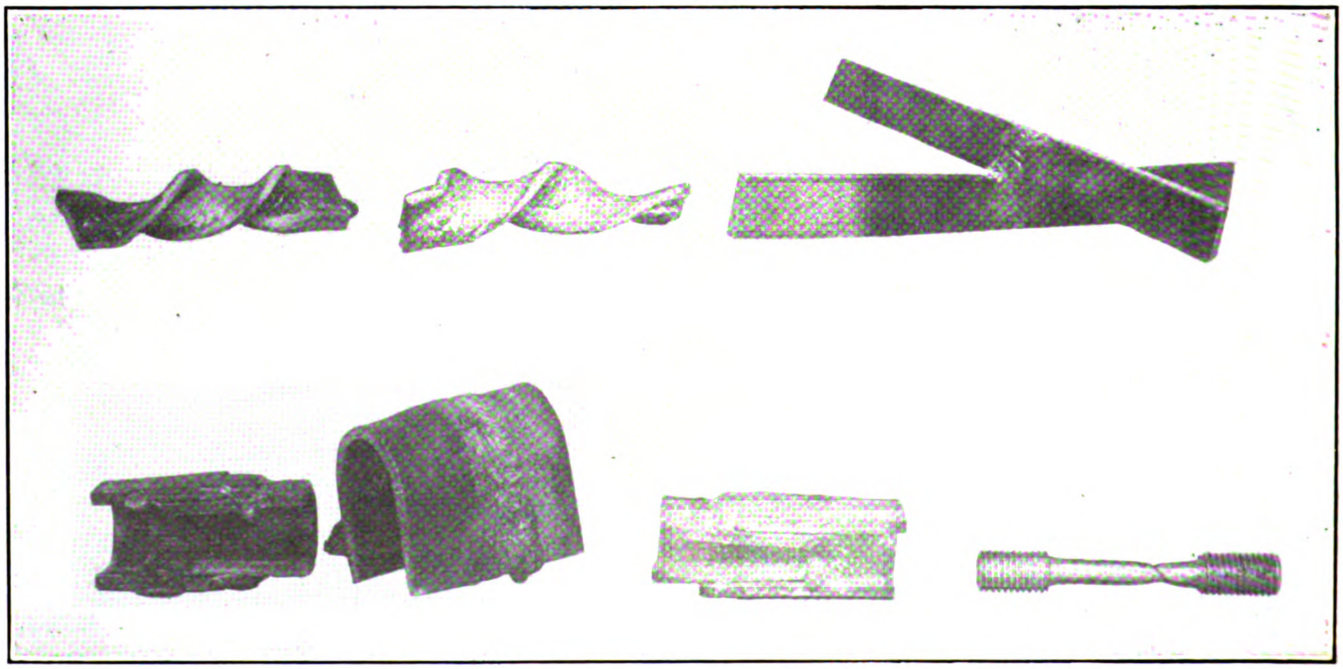

FIG. 3—Samples and tests of electric welds produced in hydrogen atmosphere.

Experiments have been conducted with several gas mixtures and various electrode materials. The best results have usually been obtained with tungsten electrodes and hydrogen alone.

Materials of many kinds have been successfully welded by this method. Low carbon steels up to one-half inch in thickness have been welded without additional material after butting together tightly. Considerable work has also been done in connection with full automatic welding using a butt joint, and with no metal being added to the seam. A number of welds have been made on seamless tubing having a wall thickness of one-quarter inch and an outside diameter of four inches, and with boiler plate iron one inch thick. Welds on deoxidized copper such as silicon-copper have been made up to three-eighths inch thick metal, giving unusually good sections.

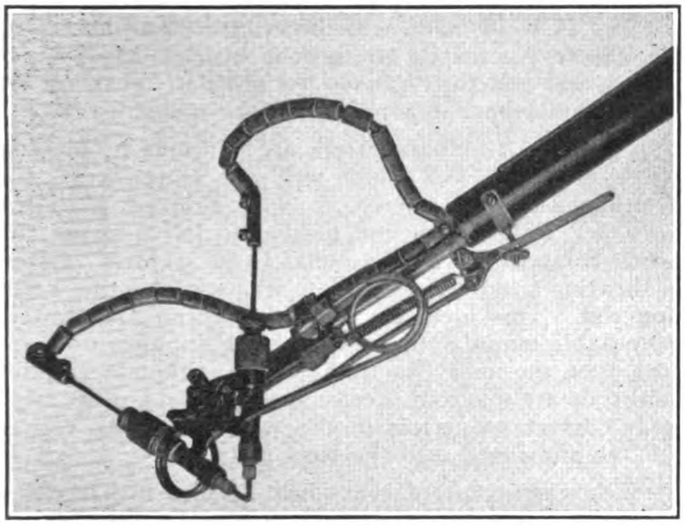

FIG. 4—Atomic hydrogen arc welding torch, type II.

In testing welds made by this process, the welded portions have been twisted and bent double without cracking or otherwise being injured. Such a procedure has not been possible with the ordinary arc weld, since such welds are usually brittle because of the presence of nitrides or a thin film of oxide or scale, removed in the new process by the presence of hydrogen.

Welding in Gaseous Atmosphere.

By surrounding the ordinary welding electrodes with an atmosphere of hydrogen or certain other gases, it has been found by Peter Alexander of the Thomson Research Laboratory of the General Electric Company at Lynn, Mass., that it is possible to produce ductile welds. The gas acts as a flux and shield against the oxygen and nitrogen of the air; therefore the formation of oxides and nitrides of iron in the molten metal is prevented. The process originated from the study of metallurgy of the arc-deposited metal and the causes that limit its ductility.

The mehod is based on the action of molecular hydrogen. This gas at high tempertures, even in the molecular state, is a very active reducing agent. When it surrounds the crater of the arc it acts in the same way as it does in the hydrogen brazing process. Yet certain peculiarities of the process (for example, the extremely high voltage drop at cathode and anode of the arc burning in hydrogen) are due to the dissociation of the small amounts of molecular hydrogen in actual contact with the craters. Hence the apparent resistance of the arc, and consequently the amount of energy liberated is about double that when the arc is burning in air.

Consequently the weld is not only ductile, but the operation is much faster. The speed results both from the greater energy of the arc in the hydrogen atmosphere and the fact that beveling of the edges of the material is unnecessary. Using 180 amperes and an arc voltage of 60, one-quarter inch boiler plates, butted together without beveling, have been welded at a speed of 60 feet per hour.

Welds Are Extremely Ductile.

Ductility is a factor of prime importance in the welds of structures that are subjected to vibration, accidental bending stress, or overload. Also, ductility equalizes internal cooling stresses when present in the weld. If any part of the ductile weld is stressed beyond its elastic limit, it will not crack. It will yield until the stresses are more or less equalized all along the joint, which is so proportioned as to stand with safety the imposed load. It has also been found that the metal deposited in the hydrogen atmosphere has a higher elastic limit. The elastic limit of pure iron electrodes before deposition averages 29,000 pounds per square inch; the elastic limit of the same electrode deposited by the arc in hydrogen averages 42,000 pounds per square inch.

In this welding process the arc is maintained inside of a hydrogen stream which burns along its outer surface by contact with air. The electrode is entirely surrounded by hydrogen, which eliminates the possibility of the metal in the crater coming in contact with air. Direct current is used. The equipment as developed in the laboratory includes the d.c. generator, gas hose, and spool of welding wire mounted as a unit on one base, The welding wire, the hydrogen gas and the electric current are sent through a flexible hose to the torch nozzle.

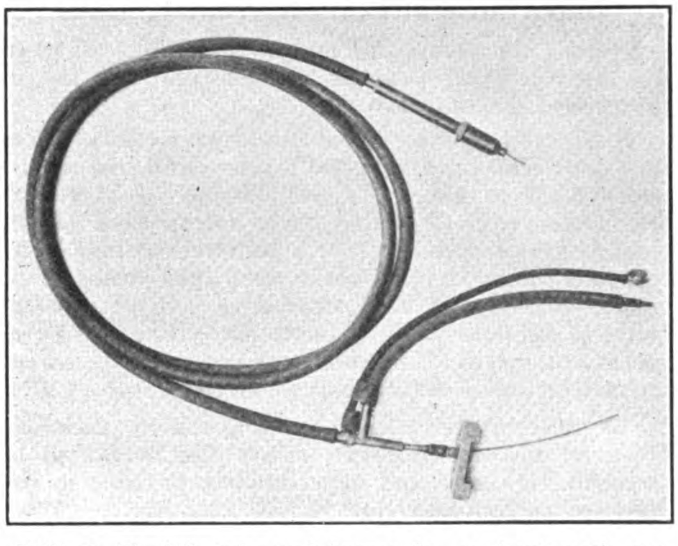

FIG. 5—Flexible tube and burner for semi-automatic arc welding in hydrogen atmosphere.

Other Gases Used Successfully.

After the work with the hydrogen atmosphere was found to be successful, experiments with mixtures of hydrogen and carbon monoxide were conducted in accordance with Professor Elihu Thomson's suggestion, and under his personal guidance. Water gas, containing about equal volume of hydrogen and carbon monoxide, was next tried. It was found that welds produced in such an atmosphere were ductile and easier to produce. Work with various mixtures of carbon monoxide and hydrogen, produced either synthetically or by decomposition of various organic compounds, demonstrated that ductile welds can be produced in the atmosphere of any mixture of the two gases. Methanol or synthetic wood alcohol was found to serve well in this gas, so that transportation with portable outfits is facilitated.

A series of experiments with nitrogen-hydrogen mixtures showed that mixtures of these gases also give ductile welds. The use of liquid anhydrous ammonia which contains one volume of nitrogen and three of hydrogen, in this connection makes it possible to store large quantities of the gas in small volume as a liquid. Still other gases and methods are being investigated in the Lynn laboratory, and academic studies are being made of the theoretical aspect of welding in different gases.

In its present state the process is being extened to the welding of alloy steels, non-ferrous materials and their alloys. The careful selection of the appropriate gaseous mixture determined by the nature of the materials to be welded is an essential factor for successful work.

In brief, this process is a combination of an electric arc which supplies the energy and an appropriate chemical reagent which, being in a gaseous state and at extremely high temperature, acts almost instantaneously.

Importance of Correct Welding Rods

Among the several distinct factors which all work together for good welds is the selection and use of the correct welding rod.

Study and practice should improve a welder from the "poor" class to the "good" class. Still, the metals which come to him to be welded may be of almost any nature from "rotten," burnt-out furnace grates, to good gray iron pulleys, or aluminum castings. The oxwelder doing repair work must take metal as it comes—no magic touch can change a dirty piece of metal to its pure form. Consequently, the degree of success of the weld depends to a considerable extent on this factor of defective base metal.

By selecting the correct welding rod for each job, however, the operator can insure the maximum of strength, tightness and dependability possible in the metal given him to weld.

In the rod rack beside a great·many welding tables can ordinarily be seen but four kinds of rod: Mild steel copper-coated, cast iron, bronze, and aluminum. Of course these rods are right for many classes of work provided they are of high quality, and are purchased from a supplier whose reputation is a guarantee of uniformity.

Usually it is not enough simply to specify "25 lbs. of ¼-in. steel" when ordering welding rods from a jobber. Without further designation, the welder generally gets ordinary copper-coated mild steel welding rod. He may reason: "Steel is steel, so I'll weld all steel jobs with this steel rod." However, when he tries to develop full strength in a particular job, he will run into trouble.

Various kinds of steel rods have been developed for different duties. If a steel shaft, for instance, is to be welded, a good grade of nickel steel rod containing about 3.50 per cent nickel should be used, because a much higher tensile strength is required for a shaft repair than can be obtained with a mild steel rod. As an illustration of how the strength varies with the rod, the average tensile strength of a weld made by an experienced operator with mild steel rod in ½-in. test plate is about 45,000 lbs. per sq. in. A weld made with nickel steel rod, however, should have a tensile strength of over 60,000 lbs. per sq. in. and generally causes the piece to break in the base metal some distance from the weld.

Equipment manufacturers are continually seeking to develop new rods which will give better welds for routine uses. Formerly, it was assured that for ordinary welding the rod needed to be of about the same composition as the metal to be welded. Often a shearing from the same plate was used for the welding rod. This idea has long since been abandoned. Reputable manufacturers of welding supplies now insist upon the most exacting control at the steel plant, and rods are made to precise specifications in order to give correct properties in the weld, after the rod is melted and fused into the base metal.

Tests are made of every heat to insure that these rigid specifications are maintained. In fact, every coil of rod is inspected very carefully. Specifications include methods of manufacture, limits of chemical composition, physical properties of the metal, character of finish of the rods, action under the welding flame, physical properties of the welds produced, and other special requirements peculiar to each metal.

Thus, from the manufacturer's standpoint, everything is being done, in the light of present-day knowledge, to put welding rods on the market which are particularly suited for joining commercial metals and which can be depended upon to be uniform, day in and day out. But all this effort will be in vain if the man who is on the other end of the line, the oxwelder, does not use the correct rod for his work, and selects the rod he uses with a thought for quality. Shoe manufacturers make many different sizes and grades of shoes. A person wearing a number 8-D buys an 8-D and not a 12--EE; and when a man wants a shoe to give him long and satisfactory service he is not content to buy from a job lot in a bargain basement. So it should be with an oxwelder choosing the rod with which to make a weld.

Every oxwelder naturally wants his welds to stand up. If he uses the wrong rod or a "bargain basement" rod his weld may fail, for the principle, "a chain is no stronger than its weakest link," holds true.

In buying welding supplies, as everything else, you get what you pay for; no one can afford to put time and effort and the best materials into a product and then sell it at less than cost. Therefore, the thoughful oxwelder will not try to save pennies by buying a cheap rod from some unknown manufacturing source. He will always find that there's a joker somewhere, and the "joke" will be on him when the job comes back to be done over. The best rods he can buy will always be the cheapest in the end.

Combustion in O. H. Furnace with Special Reference to Automatic Control*

By **K. HUESSENER**†

ONE of the purposes of combustion control is to make the furnace independent of the chimney effect of the checker chambers for the supply of air. For this purpose, an induced-draft fan is installed, usually in the passage between the two regenerator chambers as shown in Fig. 3. The air is taken into the fan through an intake box carrying an orifice plate. The quantity of air entering the fan is thus measured by the draft set up in this intake box, which represents the drop from atmospheric pressure through the orifice. From the fan, the air is conveyed to an auxiliary air-reversing valve, which consists of a steel-plate box equipped with cast-iron mushroom valves. These latter are tied in with the operating mechanism of the main reversing valve, so that their reversals are automatic, together with the reversals of the furnace.

Fig. 3 shows an open hearth furnace which is equipped for coke oven or natural and producer gas. If the furnace is fired with either coke oven or natural gas, the quantity of gas is measured by an orifice plate in the main gas supply pipe ahead of the reversing valves. For the purpose of having the quantity of air that enters the regenerators automatically follow the quantities of gas passing through the orifice plate, a combustion regulator is used.

This combustion regulator consists of two pairs of concentric double bells. As gas pressures often in excess of 5 lbs. are used, the smaller interior bells, which receive the differential pressures from the gas orifice plate, are sealed in mercury. The air pressures, which only range up to 7 in., are taken care of by an oil seal for the larger exterior bells, which are piped up to the air intake box and the atmosphere respectively.

The principle of the regulation is as follows: If the differential pressure set up by the gas orifice plate is represented by the equation $G1 - G2$, in which $G1$ is the higher and $G2$ the lower gas pressure, and in the same manner, the differential pressure set up by the air orifice plate by $A1 - A2$, in which $A1$ is the higher air pressure (in this instance atmospheric) and $A2$ the lower air pressure; and if further, the ratio between gas and air pressure which it is desired to maintain at all times is $1:z$; then the regulation would be represented by the following equation:

$$G1 - G2 = z(A1 - A2) \text{ or}$$
$$G1 + z.\,A2 = z.\,A1 + G2$$

The action of the regulator follows this second equation. The double bells on one side of the beam receive the higher gas pressure and the lower air pressure, and the pair on the other side the higher air and the lower gas pressure. The ratio $l:z$ is being taken care of by making it the relation between the areas of the gas and the air bells.

The bells are carried by a common beam supported by a fulcrum. The motive power of the regulator is a compressed air cylinder, the pilot valve of which is geared to the above mentioned beam. The piston rod of the motor is connected to a butterfly valve arranged in the combustion-air supply main. If the gas flow to the furnace increases, the difference $G1 - G2$ becomes larger, with the result that the pair of bells that receive the higher gas pressure will move up, compressed air will be admitted through the pilot valve to one side of the piston that moves to open the air butterfly-valve, until the equilibrium between $G1 - G2$ and $z \times (A1 - A2)$ is restored, when the regulation stops. Assume, for instance, that the furnace is operated on coke-oven gas and is passing gas at the rate of 150,000 cu. ft. per hour and air at the rate of 750,000 cu. ft. per hour, and that, the charge having been melted down, the gas has to be reduced to 80,000 cu. ft. per hour; then the amount of combustion air admitted will immediately and automatically be reduced to 400,000 cu. ft. per hour, thus still holding the same relation of one volume of gas to five volumes of air.

If it is desired to change the character of the flame during the operation of the furnace, the relation be-

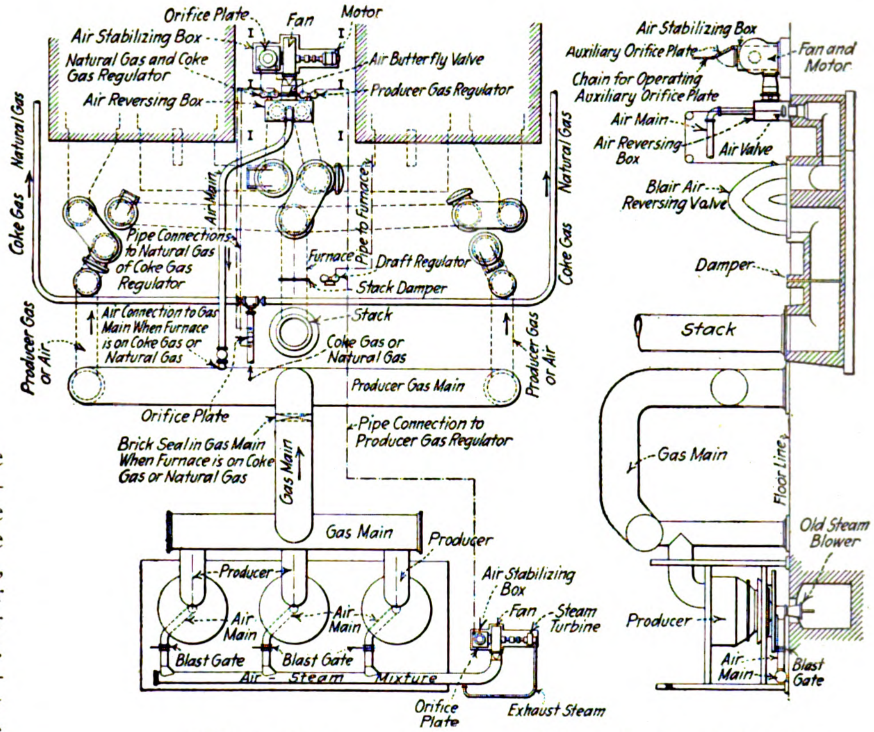

FIG. 3—Plan. **FIG. 4—Sectional elevation.**

General layout of installation with furnace equipped for firing with natural gas, coke-oven gas or producer gas.

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*Presented before the American Institute of Mining and Metallurgical Engineers.

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tween gas and air can immediately be changed by changing the size of the air-orifice plate on the air-intake box. This can be done by inserting a second smaller orifice plate in a frame that from the operating floor can be immediately lowered over the larger air-orifice plate. The connection between the reversing valve and the air regenerators is usually made underground (Fig. 4). The portion of the combustion air, that is to be sent into the gas regenerators, is either sent to the producer gas main, not in use, if the furnace is equipped for such gas, or into the air-inlet openings.

Producer-Gas Furnace Regulation Difficult.

Regulation of a producer-gas furnace is difficult because hot producer gas cannot be reliably measured. For this reason, the regulation for producer-gas furnaces follows the principle that the air supplied to the producers is measured and that the combustion-air flow is automatically kept in strict relation to the producer air-flow. In order to equip for regulation an open hearth fired with producer gas, a blower to supply air to the producers must be installed. Preferably, this blower should be driven by a steam turbine of such size that the exhaust steam is just enough to supply the steam needed by the producers. Figs. 3 and 4 show diagrammatically such an installation for a three-producer plant. The producer blower is also of the single-inlet type equipped with an air-intake box and an orifice plate, so that the suction in the intake box, being the drop from atmospheric pressure, is a measure of the rate of flow of primary air into the producers and, thus, of the amount of gas generated. The other equipment for regulation is the same as that described for coke-oven and natural gas, except that the type of regulator used is the one shown in Fig. 6. This regulator consists of two single bells carried by a common beam and fulcrum. One bell is connected to the air-intake box of the combustion-air fan and the other to the air-intake box of the producer fan. The two orifices carried by the intake boxes are of such size that at equal suctions the desired relation between producer air and combustion air is automatically upheld.

A furnace so equipped is operated by the heater on the floor, who is in control of the steam valve governing the supply of steam to the turbine of the producer air-blower. By opening and closing this valve, he will absolutely control the quantity of gas admitted to the furnace. This furnace becomes a one-valve control furnace. By admitting more steam to the blower, more air is sent in to the producers, more gas is produced and sent to the furnace, and automatically the right proportion of additional air is admitted to the furnace when the combustion regulator automatically opens up the butterfly valve in the combustion-air supply main.

This method of regulation is based on the assumption of a constant relation at all times between the amount of air needed to make a given quantity of gas, and the amount of air needed to burn this same quantity. It must, of course be admitted that this regulation can only be 100 per cent. correct for one given quality of gas, and that it will become more or less incorrect as the quality of the gas changes. It must be kept in mind that the gas producers will receive their air under fan pressure, and that a constant relation between air and steam is always maintained by watching the temperature of the air-steam mixture. If desired, the saturation temperature of the producer air can be automatically maintained constant. This has so far not been found necessary, as it was possible to choose a turbine of such steam consumption that the exhaust steam was kept in a very close relation to the quantity of air delivered by the fan. The result is a much more uniform gas than is usually obtained from producers that are blown with steam jet blowers.

Uniform Quality of Producer-Gas Essential.

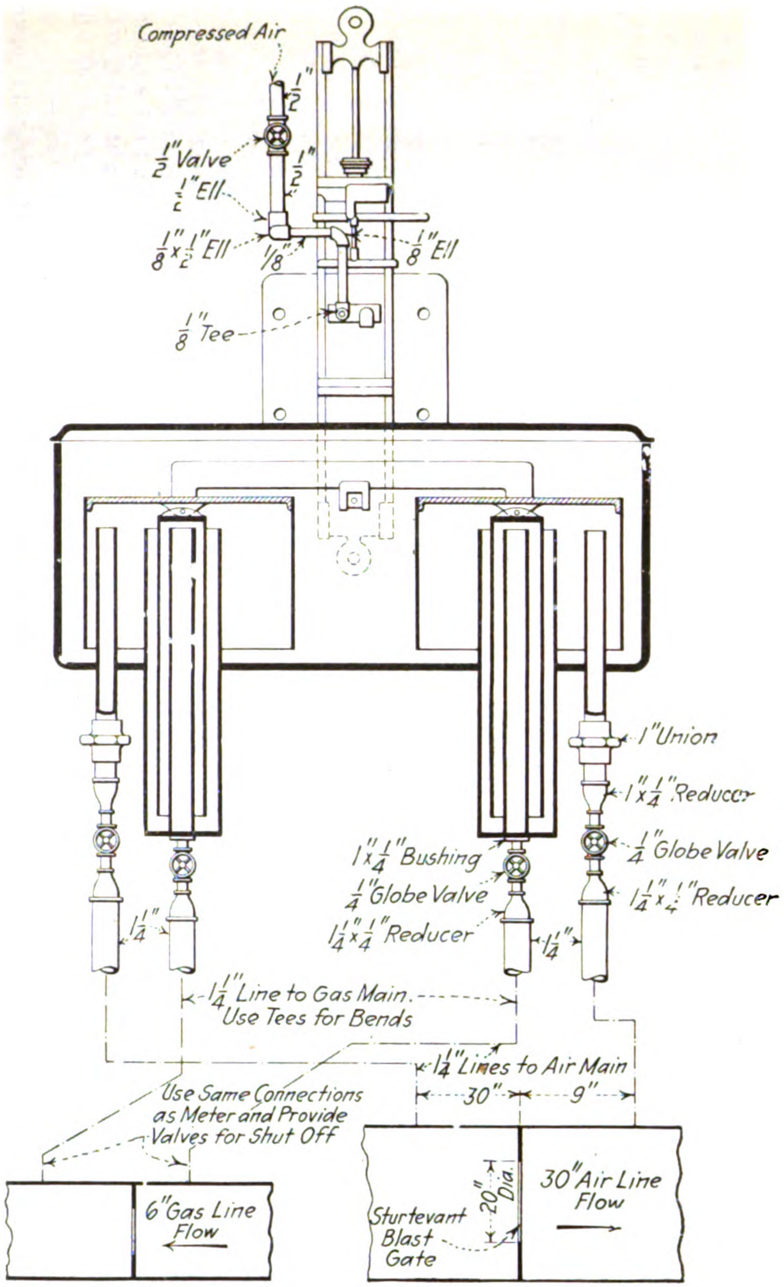
There is no excuse for really large changes in the quality of the gas from producers equipped in this manner. If the height of the fuel bed is carefully watched by frequent use of measuring sticks, if the producer, when it happens to need poking, is throttled down, for which purpose blast gates are supplied in the air leg to each producer; if, finally, the poking of the producer is generally done while the furnace is being tapped and charged; then there is no excuse for larger variations in the quality of the gas than about 10 B. t. u. per cu. ft. and then only for short periods during the poking time. Such small variations will not in any serious way effect the correctness of the regulation.

Generally speaking, of course, it can not be claimed that automatic regulation applied to existing open-hearth furnaces can ever be 100 per cent. perfect. Although every effort is made to eliminate air infiltration into the checker chambers and the uptakes by suitable regenerator covering, such air infiltrations cannot entirely be avoided. On the other hand, it has been ascertained by careful measurements that between 85 and 90 per cent. of the total combustion air is actually being regulated, whereas only 10 to 15 per cent. passes into the furnace as infiltrated air without being regulated. Although the desirability of regulating all the combustion air is self evident, the error in allowing 15 per cent. to pass in unregulated, is not very serious because the infiltrated air usually remains constant. By means of flue-gas analyses the regulation is set for the largest quantity of gas needed during melting. If the regulation is fully correct for this largest quantity, then, of course, as the gas supply to the furnace is cut down, the infiltrated air will bring about a certain small excess of air. In view of the fact that this cutting down of the gas to the furnace generally coincides with the reaction period of the bath, where additional quantities of air are necessary in order to burn the CO generated by the bath, this infiltrated air often obviates the need of changing the orifice plate on the combustion-air intake box during the refining period, as is borne out by Tables 7 and 8.

Results from Regulation.

Combustion—The use of straight coke-oven gas on open-hearth furnaces has for a long time been considered inadvisable, because the flame of coke-oven gas has a rather low visibility, also because furnaces operated on such gas alone showed a distinct tendency towards foaming. The low visibility is not by any means a serious factor. Experience has shown that the helpers will soon get accustomed to the flame of straight coke-oven gas. Where visibility is nevertheless desired, a little tar or oil, say one or two gallons per ton of steel, will produce visibility without interfering with the regulation.

The problem of the foaming was approached with much misgiving. Accordingly it was a very agreeble



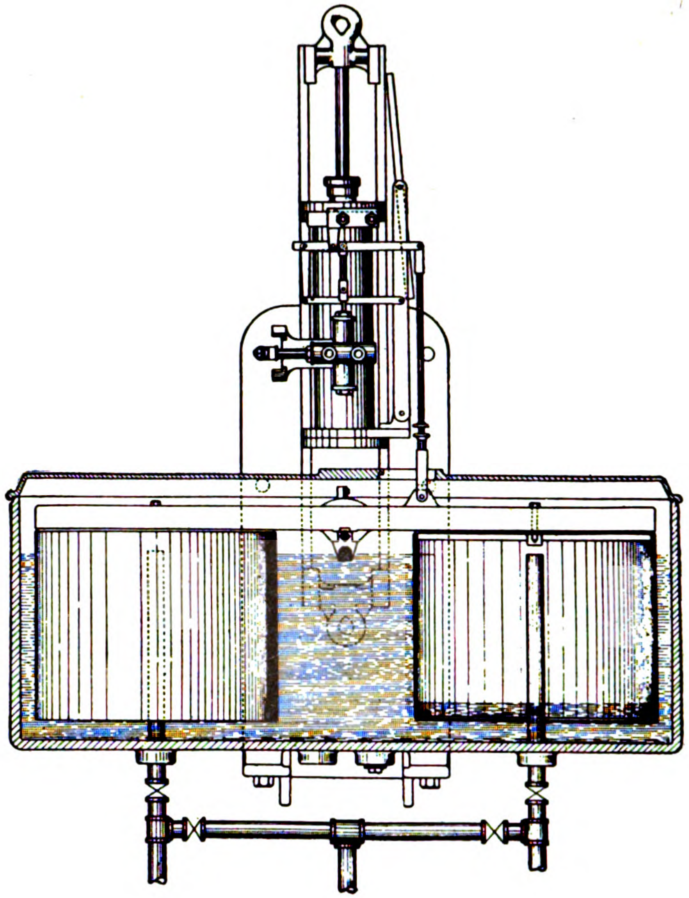


FIG. 5 (left)—Section of Huessener combustion regulator.

FIG. 6 (above)—Section of combustion regulator for producer-gas furnace.

surprise to find that no foaming existed with regulated combustion on furnaces fired with straight coke-oven gas. The explanation for the fact that no foaming took place, may be found in the uniformity of temperatures that are being maintained in an open-hearth furnace with automatic control This would tend to show that the foaming may be due to a temporary decrease in the temperature of the furnace, resulting in a cooling of the slag on top of the bath, which then, on account of its increased viscosity, will lose part of its heat conductivity, with a consequent reduction of the activity of the bath. The heat transfer from the flame of coke-oven gas, probably because it contains very little free-burning carbon, does not appear to be strong enough to break through the foam and restore the activity of the bath. From experience of nearly two years, it appears to be safe to assume that foaming is the result of poor combustion, and that with controlled combustion, it seldom happens. In any case, the fear of foaming should not prevent the use of straight coke-oven gas as open-hearth fuel and the advantage of positive automatic control. If burners suitable for coke-oven gas and tar are adopted, tar can always temporarily be put on the furnace to break up foaming, should it occur.

Straight Coke Oven Gas an Ideal Fuel.

Straight coke-oven gas has proved an ideal fuel for open-hearth furnaces, provided its combustion is always properly controlled. Furnaces have thereby been very considerably speeded up and at the same time cost of repair has been greatly reduced and the life of the furnace has been increased.

Table 7 shows a number of combustion analyses taken during one heat on a furnace equipped with automatic control and using coke-oven gas. It very closely shows to what extent control of combustion is possible. The increase in oxygen towards the end of the heat, when very much smaller quantities of gas are passing through the furnace, illustrates the effect of infiltrated unregulated air.

Automatic regulation on a furnace fired with producer-gas improved the quality of the gas very much. A number of analyses taken during one month showed a lowest Btu. value of 147 and a highest of 154 Btu. as against other producers not controlled with a lowest value of 115 and a highest of 150 Btu. The combustion results compared favorably with those from coke-oven gas as is shown by Table 8 which gives some waste-gas analyses taken during one heat. As the flow of gas in this instance could not be ascertained, we give the various differential air pressures of the producer air. The variations in the quantities from hour to hour are not as evident as in a furnace fired with coke-oven gas, because when these analyses were taken the furnace was already rather old and could not be forced, as would have been possible with a new furnace. Chart shown in Fig. 9 proved useful in compiling this data.

Production and Fuel Consumption.

In order to prove the speeding up of the furnaces and the consequent saving of fuel, seven 100-ton open hearth furnaces were observed, from April to November, 1925, inclusive. In three of the furnaces, Nos. 5, 6, and 7, combustion was controlled; No. 5 was fired with producer gas and Nos. 6 and 7 with straight coke-oven gas. Of the other four furnaces, which were not controlled, No. 1 was fired with producer gas, Nos. 2 and 4 with tar and coke-oven gas, and No. 3 part of the time with tar and coke-oven gas and part with straight producer gas. Of the three controlled furnaces, No. 5 was controlled only for three months, whereas Nos. 6 and 7 were continually under control. The compilation of production for each furnace omits all the repair months; therefore, the observations cover 47 months of production for seven furnaces. We can then compare operation of producer-gas furnaces for 15 months without control with three months with control, and operation for 15 months with coke-oven gas and tar without control with 14 months with control. The comparative figures are as follows:

Furnaces Fired with Producer Gas—

(a) Without control: Production during 15 operation months 86,897 tons, or 5,790 tons per month per furnace.

(b) With control: Production during three operation months 19,874 tons, or 6,625 tons per month per furnace.

Furnaces Fired with Coke-oven Gas and Tar—

(a) Mixed tar and coke-oven gas without control: Production during 15 operation months 92,398 tons, or 6,160 tons per month per furnace.

(b) Straight coke oven gas with control: Production during 14 operation months 96,311 tons, or 6,870 tons per month per furnace.

With regard to the last figure, it will be interesting to note that for the last five operation months, the production went up to 35,978 tons, or 7,195 tons per month. The above figures clearly show the large increase in production; the controlled furnaces actually delivered an average of two heats per week more than the uncontrolled furnaces.

With regard to the furnace No. 5 which has the installation controlling producer gas, it must be remembered that the three months of observation were the last three months befoe rebuilding. Since then the furnace was rebuilt and was in operation again at the end of November. The figures for the first 18 days in December showed that the furnace made 42 heats, producing 4,304 tons of steel with a coal consumption of 445 lbs. per ton of steel. At this rate of production, the furnace would make in December 7,250 tons of steel, which would exceed the best figures for straight coke-oven gas. It will be remembered that the calculations in Table 6 showed that producer gas should give slightly better results than coke-oven gas.

In compiling the fuel figures, we were under a rather serious handicap, as we could not compile the fuel consumption for all the months for which we had the production figures. We have, however, consumption figures for 11 operation months on producer-gas furnaces without combustion control and for three months with combustion control; also for 13 operation months firing with coke-oven gas and tar without control and for 10 months using straight coke-oven gas with control. The comparative figures are as follows:

Furnaces Fired with Producer Gas—

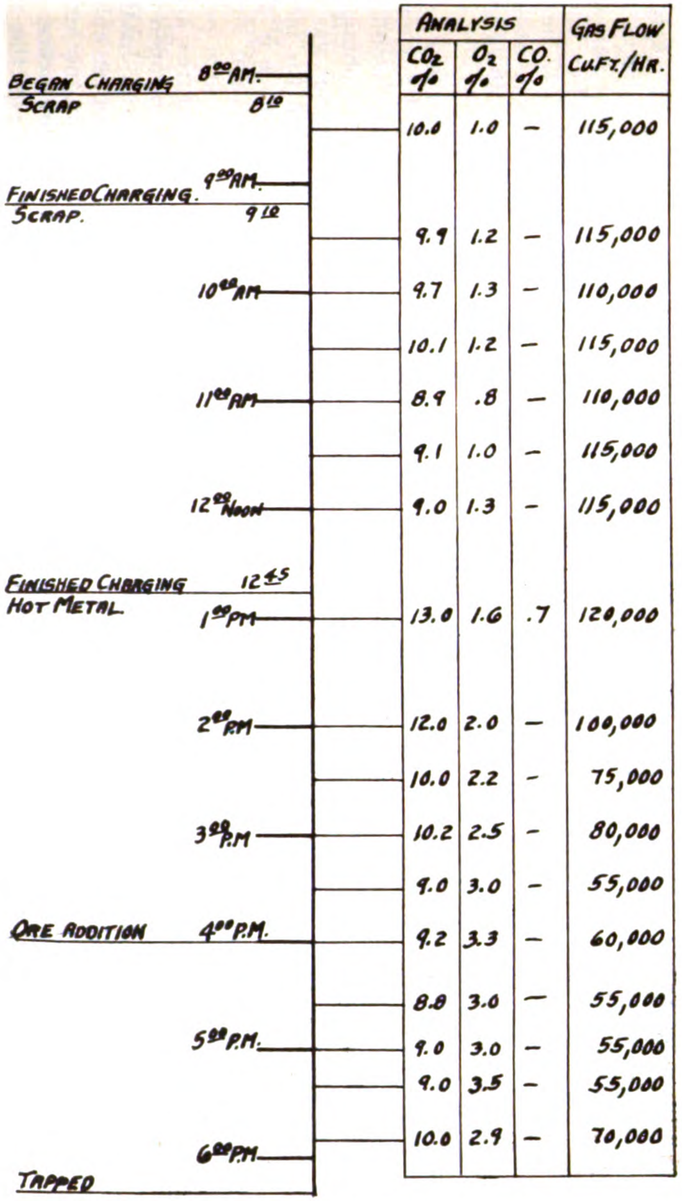
(a) Without control: During 11 operation months 62,283 tons of steel were produced with a consumption of 34,200,000 lbs. of coal, equivalent to 550 lbs. or 7.47 million Btu., in the coal per ton of steel.

TABLE 7

#6 O.H. FURNACE. COKE OVEN GAS WITH COMBUSTION CONTROL.

HEAT #6644 MARCH 14th. 1925.

WASTE GAS ANALYSIS.


BEGAN CHARGING SCRAP 8^{10}
8^{00}AM.
FINISHED CHARGING. SCRAP. 9^{10}
9^{00}AM.
10^{00}AM
11^{00}AM
12^{00}Noon
FINISHED CHARGING HOT METAL 12^{45}
1^{00}PM
2^{00}PM
3^{00}PM
ORE ADDITION 4^{00}P.M.
5^{00}P.M.
6^{00}PM
TAPPED

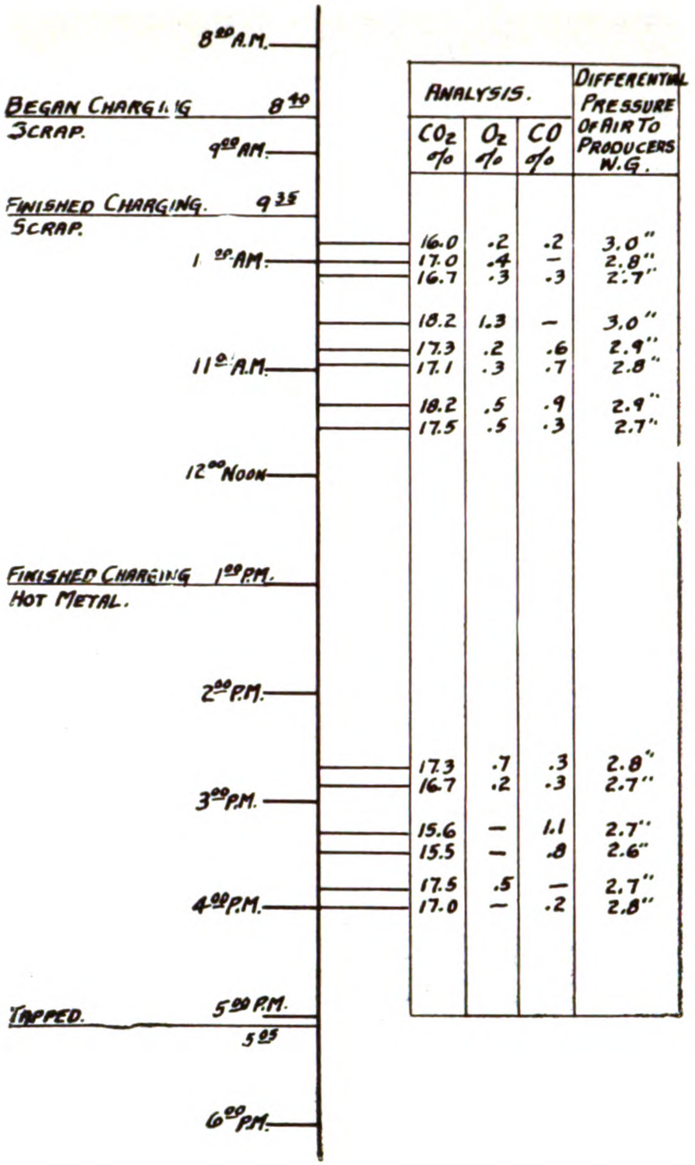
ANALYSIS			GAS FLOW
CO_2 %	O_2 %	CO. %	CU.FT./HR.
10.0	1.0	—	115,000
9.9	1.2	—	115,000
9.7	1.3	—	110,000
10.1	1.2	—	115,000
8.9	.8	—	110,000
9.1	1.0	—	115,000
9.0	1.3	—	115,000
13.0	1.6	.7	120,000
12.0	2.0	—	100,000
10.0	2.2	—	75,000
10.2	2.5	—	80,000
9.0	3.0	—	55,000
9.2	3.3	—	60,000
8.8	3.0	—	55,000
9.0	3.0	—	55,000
9.0	3.5	—	55,000
10.0	2.9	—	70,000

TABLE 8

#5. O.H. FURNACE. PRODUCER GAS WITH COMBUSTION CONTROL

HEAT #5047 SEPT. 1ST, 1925.

WASTE GAS ANALYSIS.



ANALYSIS.			DIFFERENTIAL PRESSURE OF AIR TO PRODUCERS W.G.
CO_2 %	O_2 %	CO %	
16.0	.2	.2	3.0"
17.0	.4	—	2.8"
16.7	.3	.3	2.7"
18.2	1.3	—	3.0"
17.3	.2	.6	2.9"
17.1	.3	.7	2.8"
18.2	.5	.9	2.9"
17.5	.5	.3	2.7"
17.3	.7	.3	2.8"
16.7	.2	.3	2.7"
15.6	—	1.1	2.7"
15.5	—	.8	2.6"
17.5	.5	—	2.7"
17.0	—	.2	2.8"

(b) With control: During three operation months 19,874 tons of steel were produced, using 10,200,000 lbs. of coal, or a coal consumption of 513 lbs., or 6.93 million Btu. in the coal per ton of steel.

Although the above figures showed a considerable increase in production, the fuel consumption was not reduced as much as one would expect, because the regenerators were already very old and interference of the preheat was serious. As has already been stated, the run on the rebuilt furnace shows not only a very much larger production, but also a reduction of fuel consumption to 449 lbs. of coal, or 6.11 million Btu., per ton of steel in the coal.

Furnaces Fired with Coke Oven Gas and Tar—

(a) Without control: During 13 operation months 79,225 tons of steel were made with a heat consumption of 573,830 million Btu. in gas and tar, or 7.25 million Btu., per ton of steel.

(In order not to complicate the above calculations we did not separate the gas and the tar.)

(b) Straight coke-oven gas with control.

(Separate figures are given for furnaces Nos. 6 and 7 because No. 6 was equipped with the latest type of control and, therefore gave much better results.)

(1) Furnace No. 6—During six operation months 39,215 tons of steel were produced with a gas consumption of 351.0 million cu. ft., i. e., 8,950 cu. ft., or 4.42 million Btu., per ton of steel.

(2) Furnace No. 7: During four operation months 28,207 tons of steel were produced with a gas consumption of 293.35 million cu. ft. of coke-oven gas, i. e., 10,370 cu. ft. of gas, or 5.12 million Btu. per ton of steel.

Life of Furnace and Rebuilding Costs—Regarding the saving in the life of the furnace, no figures so far are available on controlled furnaces fired with producer gas, because no complete set of tests has yet been made with a controlled furnace. With the two coke-oven gas furnaces, we have so far made only two complete set of tests. The longest run was on No. 6 furnace with 409 heats, producing 42,334 tons of steel. The total rebuilding cost for this furnace was as follows:

Bricklayers	$ 480.00
Helpers	273.70
Loading brick	144.44
General labor	1,176.56
Silica clay	72.00
Fireclay	33.00
Brick	6,359.44
	$8,539.14

The cost was approximately 20c. per ton of steel. Unfortunately exact figures as to the cost of the inter-repairs during the run of the furnace are not available, but it is estimated at not more than an additional 20c. per ton of steel, so that the repair cost does not appear to exceed 40c. per ton of steel.

The No. 5 producer-gas furnace was also rebuilt after controlled combustion in about one-half of the tests. It made during the whole series 341 heats and produced 34,808 tons of steel. The previous run without control was 279 heats, producing 29,023 tons of steel. The rebuilding cost after the run of 341 heats were:

Labor	$2,870.82
Store	208.75
Brick	5,082.03
Fireclay	38.72
	$8,195.32

The cost therefore amounted to approximately 28c. per ton of steel.

Importance of Continuous Fuel Supply.

Stress should be laid on the importance of a continuous fuel supply, not only to speed up the operation of the furnace, but also materially to decrease the fuel consumption.

When No. 7 furnace was first equipped for straight coke-oven gas with combustion control, the gas mains carrying the gas to the furnace were so small that high pressures were needed to force enough gas through them to the ports. In order to maintain these pressures, it was necessary to cut off the gas from all other furnaces, with the result that vast quantities of gas were bled. For about 12 days, this condition of very uniform gas pressure lasted. Then the small gas mains were replaced by much larger mains and the gas was distributed to many furnaces. This distribution resulted in marked irregularity of the gas pressure, because of the constantly changing demand on the gas supply. During these first 12 days, the gas consumption on No. 7 furnace was remarkably low, varying between 6,200 and 6,500 cu. ft. of gas per ton of steel. As soon as the larger gas mains had been installed and the gas pressure became irregular, this consumption increased to about 10,000 cu. ft. of gas per ton of steel, where it has since been held. At the time the author was unable to find any explanation for this sudden change in gas consumption and, therefore, came to the conclusion that the meter readings during the first 12 days must have been wrong, although an examination by the meter manufacturers did not reveal anything amiss. In September, 1925, a similar condition was created when No. 6 furnace was being rebuilt, the other furnaces were unable to take the whole of the coke-oven gas, and gas had to be bled. During rebuilding when the gas pressure was always at 5 lbs. or above, 17 heats were made, producing 1,802 tons of steel and using only 10,862,500 cu. ft. of gas, i. e., 6,028 cu. ft. of gas, or 3,134,560 Btu., per ton of steel.

As the low gas consumption was restored as soon as the conditions that prevailed during the first regulation period were restored, one would hardly be justified in discarding the results obtained during this second period as due to erroneous gas readings. The explanation will probably lie in the fact that the heat transfer in an open-hearth furnace is overwhelmingly due to radiation. As the radiation increases and decreases in the relation of the fourth power of the difference of the absolute temperatures, and as the working range of temperatures in an open-hearth furnace, which is between 3,000 deg. and 3,200 deg. F., is so limited, it is certainly quite conceivable that continuous changes up and down in the temperatures obtained may have a decided influence on the rate of heat transfer and, therefore, on the speed and fuel consumption of the furnace. If this should be true, the experience related above would be an extremely strong argument for a gas holder in connection with every coke-oven gas open-hearth plant. It is regrettable that the author heard of this astonishingly favorable run only after the conditions under which it was possible had ceased to exist, so that the necessary data to prove the possibility of this low fuel consumption could not be collected. Generally speaking, of course, Table 6 shows that low fuel consumptions of this kind are not by any means impossible, even with open-hearth furnaces of the present customary design.

Conclusions.

The author emphasizes the necessity of a large number of exact heat-balance sheets under varying conditions, laying special stress on the need of particular care in temperature measurements.

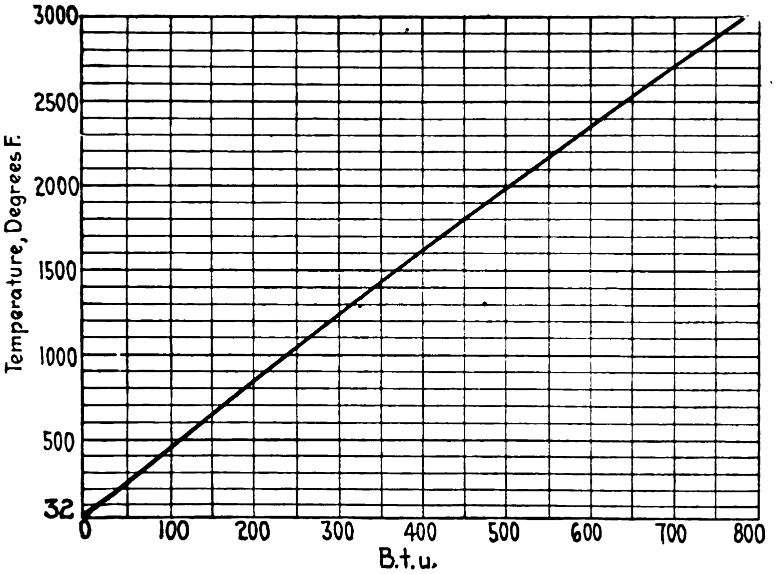


FIG. 9—Heat content (above 32 deg. F.) in Btu. of 1 lb. of dry air.

Preheating temperatures for the present type of checker chambers are naturally low and on new construction, particular care should be taken not only to increase the size of the checker chamber, but also to obtain equal distribution of outgoing and ingoing gases over all parts of the checker chambers.

The results obtained from an open-hearth furnace depend on the amount of gas completely burned for a given period, and on as low an excess of air as is possible. This necessitates the installation of forced-draft and induced-draft fans and equipment with automatic combustion control.

Acknowledgement.

Appreciation is hereby expressed for the care and interest taken by all participants in this work in observation, tabulation and making drawings.

Eyes Protected at Charging Furnace

Eye protection for workers at the charging furnaces in the plant of the Timken Roller Bearing Company, Canton, Ohio, is provided by a pane of safety glass 18 by 24 inches and ¼ inch thick. Blue glass, similar to that used for melters' goggles, is used in a wooden frame, and four inches in front of it is another frame covered with copper screen to break the heat and protect the glass.—National Safety News.

Program for Steel Treaters' Spring Meeting

The Technical program for the spring sectional meeting of the American Society for Steel Treating, to be held at the Hotel Bond, Hartford, Conn., May 20-21, has been arranged as follows:

Thursday, May 20, morning technical session, F. P. Gilligan, chairman:

"Recrystallization Temperatures of Cold-Rolled Electrolytic Iron and Open-Hearth Steel Strip", by John R. Freeman, Jr., Bureau of Standards, Washington, D. C.

"Factors Affecting the Machinability of Alloy Steels", by J. S. Vanick, International Nickel Company, New York.

Friday, May 21, morning technical session, A. H. d'Arcambal, chairman:

"Necessary Precautions in the Manufacture of Alloy Steels", by Marcus A. Grossman, United Alloy Steel Corporation, Canton, Ohio.

Forging by the Upset Process", by J. C. Kielman, New Departure Mfg. Company, Bristol, Conn.

Evening technical session, S. P. Rockwell, chairman:

"The Role of Stainless Iron and Steel in Industry", by Norman L. Mochel, Westinghouse Electric & Mfg. Company, Philadelphia, Pa.

"Heat Treatment of Die Blocks", by Alfred J. Porter, Jr., Heppenstall Forge Co., Bridgeport, Conn.

Visits at various plants have been arranged for the afternoons of both days, the companies which are offering these facilities being the Billings & Spencer Company, Colt's Armory, Hartford Rubber Works, Pratt & Whitney Company, Royal Typewriter Company, Underwood Typewriter Company, Union Drawn Steel Company, and the New Departure Mfg. Company.

The banquet has been arranged for Thursday evening at 6:30. There will be a meeting of the board of directors at 10 A. M. Wednesday, May 19, and also what is termed an "early bird's dinner" at 6 P. M. on the same day.

Building New Strip Mill at Weirton

An appropriation of $5,000,000 has been authorized by the directors of the Weirton Steel Company for the construction of a new strip mill at Weirton, W. Va. This expenditure is in addition to the $15,000,000 expansion program announced last year. All construction, grading, excavating and concrete work will be done by the company. Contracts for the strip mills have been awarded to the United Engineering & Fdry. Company, Pittsburgh.

Additions to the present open-hearth department, which are a part of the recently announced expansion program, will include four 100-ton basic furnaces. The first of the new furnaces is expected to make its initial heat in August. A new coke plant including 49 by-product ovens is being erected by the Koppers Company, Pittsburgh. Foundations for the company's new 800-ton blast furnace are now completed and erection of the stack will start within the next ten days. Contracts for building the furnace and the stoves recently were awarded to W. B. Pollock Company, Youngstown, Ohio.

Warming Up Sheet and Tin Mill Rolls

The Necessity of Carefully Warming-Up Chilled Rolls in Order to Relieve the Strains Set up by the Drastic Cooling When the Rolls Are Cast, Is Emphasized

By W. H. MELANEY*

ONE of the most abused practices in sheet and tin mills is the warming up of the rolls to get them in proper condition to start the turn's work Not all of the rolling mill operators fully appreciate the extreme sensitivity of a chilled roll to heat conditions, especially the first time it is warmed up. This fact is responsible for many broken rolls. Preparing the rolls in the quickest and easiest manner for properly rolling the size and type of sheet on which the mill is to start rolling, is antagonistic to conditions that would produce the longest life in the roll.

Casting Strain in Rolls.

All chilled rolls due to the manner in which they must be cast, that is by very rapid cooling of the outside surface while the center of the roll is still molten, embody inherently a certain amount of strain which later on is gradually eleminated due to the annealing caused by the gradual heating up of the roll in the rolling of sheets and its continually remaining at this heat during the first week's work. After the roll has passed through this first annealing period its susceptibility to breakage is very much reduced.

The statement can be safely made that the majority of rolls that finally break in service later on, have received on their first warming up the conditions that caused them to break, perhaps weeks afterward. At least 90 per cent of all sheet and tin rolls broken are due to conditions arising from warming them up too rapidly at some time or other in their existence.

Rapid Expansion to Blame.

It is a well known fact that the chilled surface of a roll due to its crystalline structure, has an expansion double the amount of the dark grey iron composing the center of the roll and the sprey or mottled portion existing between the crystalline chill and the grey iron has an expansion half way between these two extremes.

This is why it is considered poor practice in roll making to have too little sprey or mottle between the white crystalline surface and the grey iron composing the center of the roll.

This mottle is the means of smoothing out the great difference in expansion between the two. Take for instance a roll 44 in. long; this roll when fully heated will be from one-quarter to three-eights of an inch longer than it was when cold. Now if the outside chilled surface expands twice as fast as the inside grey iron at the same temperature (and this is a fact not theory), and if you heat the outside of the roll first which is the only known way of doing it, the outside surface of the roll will be quite hot before the center portion of the roll is even warm.

This practically doubles the co-efficient of expansion between the outside and inside again making the ratio of expansion between the two about four to one. Now what happens? We know, of course, the entire roll is longer than it was before the heating and as the inside has only expanded about one-fourth of this amount, the inside portion must of necessity have stretched the balance and this is exactly what happened.

But as grey cast iron is a soft spongy substance compared to the chilled outside if it is warmed slow enough it will stretch this necessary amount without rupture by simply opening up the grain of the grey iron, but if warmed too rapidly the grain of the grey iron is simply pulled apart and you have a rupture of the grey iron at the center of the roll and there is nothing holding the roll together but the chilled outside and the mottle.

This condition may exist for weeks and is of course invisible to the eye but later on, due to the jar from the pounding of the rolls together, it lets go and the roll breaks in two (many times when the working conditions on the mill are perfect).

Breaking Under Perfect Rolling Conditions.

This has always been a mystery to some of the mill men who insist the roll never had any abuse but broke under perfect rolling conditions. However, the fact remains that this is not when the roll ruptured but merely when it came apart.

Imagine if you can, any logical reason why a roll should break through its strongest part from pressure when that pressure must be transmitted through the weakest parts (the necks and wabblers) to do this breaking.

The center of a roll is stronger than the housing that carries it so why should not the housing break first? The answer is that its not pressure that breaks rolls but heat.

Now do not misunderstand this assertion. The writer does not deny that the amount of screw on a mill is not a contributing factor—Why? Because the more screw that is used on the pack the quicker the rolls warm up, and the greater will be the breakage but this is only another way of introducing heat into the roll. Also when the roll has already been ruptured on the inside from too rapid expansion then excess screw will cause it to come in two sooner.

Critical Point.

Another point the writer wishes to emphasize is that the rupture is most likely to take place during the time the roll is being warmed from air temperature to several hundred degrees above this point because of the great difference in temperature that exists between the outside surface and the inside or center of the roll.

After a roll has been warmed clear through to its center it will stand more rapid expansion with less danger of breakage than before it has reached this stage, therefore, the prevalent practice of using the same warming up methods in winter weather as is used in summer is all wrong.

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*National Roll & Foundry Company.

It makes all the difference in the world whether a roll is to be warmed up from a winter temperature of near zero to say 300 deg. or from a summer temperature of 80 deg. to 300 deg. in the same time yet this is what is universally done.

After this temperature has been imparted to the roll all the way through, the further warming up of the rolls to 700 or 750 deg. the full rolling temperature, is not so critical. The ideal practice would be never to let the roll get cold after once being placed in service, and this would not be a difficult matter to control as the roll need not be kept hotter than 150 deg. when out of service. This would not prevent its being dressed or otherwise handled, this is apparent when you remember that your blood temperature is 98 deg. Keeping the roll warm through to its center at all times would result in a wonderful reduction in roll breakage.

Kind of Heat Used.

It makes no difference of course what kind of heat is applied to the rolls for warming up purposes provided it is applied slow enough and evenly distributed over the entire surface of the roll at the same time. Heat may be generated from gas, electricty, steam, or hot water, but it is apparent that most of these methods can be badly abused.

Of the several methods mentioned gas is the most susceptible of abuse because it is always possible to warm the rolls faster with gas, and this is the very thing that is not desired.

However, if gas was evenly applied through a perforated pipe all over the surface of the roll and not just in the middle as is usually done, and the flame kept out of contact with the face of the roll until the roll had become heated clear through to its center using a sheet metal covering over both rolls to retain the heat generated by the gas, and the heating up extended over a sufficient number of hours to slowly heat them up, even this method could be made fairly safe and efficacious, but safety would mean taking about 10 to 12 hours to warm up the rolls especially in the winter time.

Rapid Heating Disastrous.

No roll should ever be warmed up from air temperature to starting condition in less than eight hours even in the summer.

If electricity is used the same conditions apply. The electric current should be turned on sparingly at first then gradually increased after the roll has become warm through, as it is just as possible to rupture the inside of the roll this way as with gas, if the roll is heated too rapidly.

However, the writer has called attention in a previous article to a fool proof method of warming up rolls to past the critical period at least, and that is by means of hot water.

Why is it fool proof? Because no matter who is in charge of the warming up of the rolls, he can not warm the rolls too rapidly until after they have passed the most critical stage, as at best he has not more than 180 deg. of heat at his command and it would be impossible to get more than 212 deg. as that is the highest heat water can take in an unconfined state as at that temperature it boils and evaporates. Therefore, if hot water is permitted to run over the entire surface of the roll through a perforated pipe extending the full length of the surface of the roll and this kept up for hours until the roll is warm clear through, the rolls being kept revolving during this time, no danger will result from this part of the warming up process and from there on to the final temperature the conditions will not be so critical.

Even Heating Imperative.

There is a prevailing belief that as the center of the roll is what you are trying to puff up that this is the only point to which it is necessary to apply the heat.

This theory is all wrong again because even when the heat is applied all over the working surface of the roll it will still puff up in the center due to the conduction of heat from the ends of the rolls into the necks, wabblers, housings, etc., because the center of the roll can only lose its heat by radiation into the air.

This hot water warming is the only fool proof method used to date as the roll then passes through the most critical period safely. Of course the subsequent heating up by other means to get it to the temperature necessary to properly start the turn's work can be abused if done deliberately.

Limiting Output.

In any method of warming up the first three turns at least should be limited to 80 per cent of the usual output and some limit should be maintained until the roll reaches its full working temperature. After this, during the last three days of the week, the output can be forced to make up for what was lost during the limiting period so that in the end the full output for the week has been obtained safely and there will be no loss in production.

It would seem unnecessary to call attention to the fact that the width of the sheets that can be successfully rolled on the mill should be gradually increased until the roll has reached its full working temperature and gradually reduced again toward the last of the week as the rolls wear more hollow.

Open Hearth Production Records Broken

A new high ingot production was established by the United Alloy Steel Corporation, Canton, Ohio, during March, according to George H. Charls, president, greater tonnage being produced on the 14 furnaces than had formerly been produced when 22 furnaces were in operation. Orders booked, sales and shipments for the first quarter of 1926 ran in excess of the same period last year.

The United Alloy Company is producing rustless heat-resisting irons. Enduro, which is a high-chromium, low-carbon alloy iron, first originated in Europe, but was improved upon and put into quantity production in the United States. It has splendid possibilities for articles in which corrosion is a problem to overcome. In many places it is supplanting copper, brass, nickel, and aluminum, because of its greater strength and non-tarnishing qualities.

Pipe Mill Is Planned

Action by the stockholder of the Bethlehem Steel Corporation in approving the issuance of new 7 per cent, cumulative preferred stock, assures early execution of the plans of the company to erect a pipe mill at Sparrows Point, Md.

Lubrication Discussed at Symposium

Abstracts of Papers Presented at a Meeting of the American Chemical Society, Division of Industrial and Engineering Chemistry, Tulsa, Oklahoma, April, 1926

"Characteristics of Full and Partial Bearings," by H. A. S. Howarth. This paper, excepting the parts referring to "Total Friction in Full Bearings," and the "Viscosity-temperature Conversion Chart," is a resume of three contributions by the author to the A. S. M. E. in 1923, 1924, and 1925, entitled "A Graphical Study of Journal Lubrication."

The hydrodynamical theory of lubrication, developed by Osborne Reynolds and amplified by W. J. Harrison and others, forms the basis of this analysis. W. P. Harrison presented the subject in simple form before the Philosophical Society, Cambridge, England, in 1913. His formulas and symbols are used in the present paper so far as they apply.

This graphical analysis is therefore a development of the two dimensional theory, originating with Reynolds, which leaves side leakage out of account, and assumes that the oil viscosity is constant throughout the film. The influence of friction upon the direction of the resultant force of the oil film upon the bearing surfaces is neglected in the examination of partial bearings herein because of its relative insignificance for partial purposes.

The types of bearings to which this analysis is applied are as follows:

1—Bearings, bored with running clearance:

(a) Full or complete bearings.

(b) Central partial bearings in which the line of action of the resultant load bisects the bearing angle.

(c) Offset partial bearings in which the line of action of the resultant load intersects the bearing surface, usually more than half way from the leading edge.

2—Bearings fitted carefully to the journal, as no running clearance is provided, these bearings must be less than 180 deg. long in order to function.

These types have been studied graphically on the basis outlined in order to provide a complete and thorough set of fundamental laws which must govern the actual lubrication of all plain journal bearings. The bearing characteristics as given in this paper represent ideal conditions in that they show the maximum film thickness which may be realized for a given load. These laws may serve as a guide in the study of actual bearings in which such factors as end leakage and surface roughness play a modifying part and prevent the carrying power from being as great as in the ideal case.

As an example of the use of these laws is cited the question as to the advantages of employing two or more pivoted segments instead of a single partial bearing to support a journal. It can be readily shown that the film is thinner in the case of the bearing of two segments, the total arc of each bearing, and other conditions being equal. In a similar manner a three-segmented bearing is inferior to one of two segments. It is quite probable that many bearing problems may be solved at least approximately by the graphical method once its usefulness and limitations are thoroughly understood.

"The Function of Graphite in Lubrication," by F. L. Koethen. This paper describes tests on a Rhiele machine to determine the amount of pressure required to rupture the fluid film in a 3-in. bearing rotating at constant speed, and measurements of the coefficients of friction of weighted sliders, in each case using oil with and without suspended graphite. Both methods of test showed that under conditions of ruptured film lubrication with some solid contact, the presence of graphite substantially reduced the friction.

The Effect of Surface Action on Fluid Film Lubrication," by A. E. Becker. To obtain fluid film lubrication there must be adequate adhesive forces between the lubricant and the bearing surfaces. This indicates four general types of bearing combinations. There being no known method for measuring these adhesive forces the writer has devised apparatus for measuring the film thickness developed. This apparatus is described and data for four oils and four bearing combinations presented. The general equation for film thickness in terms of load, speed, and viscosity is found to be:

$$T = K \left(1 - \frac{\log P}{A}\right) \quad \left(1 - \frac{\log S}{B}\right) \quad \left(1 - \frac{\log P}{C}\right)$$

where K, A, B, and C are constants depending upon surface action forces.

"Oil Flow in Journal Bearings," by D. P. Barnard. This paper represents an attempt to present the basic laws of fluid film lubrication in such a manner that they may be readily used in the correlation of test data. As is well known these laws are founded upon the properties of the viscous flow of fluids. The work of Reynolds and Harrison has served to outline the laws governing carrying power and film thickness. This paper describes a simple method of development of the approximate laws controlling oil flow through bearings and presents some experimental data in substantiation of this method. In addition a visual study of oil flow has been made and will be presented by means of motion pictures.

"The Role of Oiliness in Industrial Lubrication," by W. C. Williams. An outline of the importance of efficient lubrication with a discussion on the mechanism and possibilities for improvement of this vital factor as it especially applies to electrical machinery and such other types as are not affected by intense heat is given. The property of oiliness is dwelt on as a means of improvement and after a brief review of the literature a modified inclined plane is described as a method of measuring this property. A number of determinations were made with a brass plate and steel slider lubricated with several typical lubricants. An analysis of the results shows a general agreement with those obtained by other investigators who used other metals and materials for surfaces.

1—The several lubricants, fatty oils, fatty acids, and mineral oils gave coefficients of friction in the same order of magnitude with brass and steel surfaces as reported for other materials by other investigators.

2—A comparison of a Pennsylvania crude with a lubricating fraction of the same showed the process of refinement was not detrimental to the oiliness property of the oil.

3—A study of the observations made on the static friction tests indicate that an ideal lubricant would be an oil of low kinematic viscosity, fortified with a small amount of material that would build up an appreciably thick, strong adhering film of low internal friction in the rubbing surfaces.

4—It is also indicated that even if Amontons law is theoretically true it does not strictly apply to practical lubricating surfaces.

"Relations Between Certain Physical and Chemical Properties of Oils and Their Lubricating Value," by L. W. Parsons and G. R. Taylor. A brief review of the theory of lubrication is given and the application of this theory to a few special cases is considered. The necessity for the use of tests which will indicate the relative tendencies of oils to deteriorate or otherwise drop in lubricating value under service conditions is shown. A discussion of data is presented on the following tests: Oxidation and emulsification of motor and turbine oils, flow of oils under pressure at low temperatures, "oiliness", and static friction. The above data are considered in their relation to lubricating theory.

"Diesel Engine Lubrication," by P. L. Scott. The demands of oil engines, especially those of high power output, require a wide range of pressures, speeds, temperatures and materials, and it is very important that the proper oil is used. On elaborate installations several kinds of oil are often used.

Lubricating difficulties in these engines are usually due to failure of the moving parts to get oil, too rapid breaking of the oil film, or dirty oil. Explosions due to oil vapor have occurred not infrequently. The oil requirements for the different parts of the engine and the various mechanisms for feeding oil to these various parts in order to prevent the first two sources of trouble are described. The value of a clean oil is brought out by two illustrations, and several methods for accomplishing this are suggested.

"Profits" Becoming Dependent upon "Power"

By R. B. Williams

At the close of the Civil War the amount of energy used in all industry and agriculture totaled only slightly in excess of 2,250,000 hp. Today, manufacturing industries, agriculture, mines and railroads, employ an annual amount of energy considerably in excess of 150,000,000 hp. This is an increase of over 1,300 per cent, and is perhaps the basic reason why the United States has reached its high level of productivity and efficiency, why individual as well as industrial earnings are so high (in comparison with other nations), and why the United States is supreme in economic importance.

With the possible exception of yachting, there is no spiritual or material blessing afforded the wealthy that cannot be enjoyed by the workingman. This is true of no other country than the United States—and that is because in no other country has the use of mechanical power been so greatly augmented.

To the extent that mechanical power is employed to carry the burden of industry, to just that extent is human power released for the more productive brainwork. The earning power of hand labor is definitely circumscribed by the demand for the product; whereas, the earning power of brain labor is limited only by the ability of the individual.

Of the various types of power, electricity has shown the most rapid increase during the past 25 years. In 1900 less than one per cent of the installed power in manufactories consisted of electric motors. Today, electricity is furnishing 70 per cent of the installed power used in manufacturing plants—the total amount of power employed by that branch of industry being well over 35,000,000 hp.

Nor has the development of electricity more than attained a good start. In the coming second-quarter of the present century electrical development will mount at an increasing rate. Already several enormous projects are under way. At Johnson City, Tennessee, five hydro-electric plants are planned, the largest of the group being the $500,000 project of the Watauga Power Company at Elizabethton. These five, however, are but a small part of the development that will soon crystallize in the territory of the Tennessee River. Already definitely conceived is the plan for the building of 100 dams which will have an ultimate output of 4,000,000 hp. The preliminary survey alone for this tremendous project will cost, it is said, in excess of $500,000, but with its completion there will come the rapid development of that southern territory which is so rich in coal, iron ore, copper, zinc, limestone, marble, phosphate and timber. To show, in small measure, what value is even now coming out of this territory, it can be said that the big Wilson dam, built at a cost of $55,000,000, gives us an annual production of power equal to a train of coal cars 1,725 miles long.

Back in the days when the writer was an ardent student of the life of Nick Carter, he remembers his father voicing the belief that one day engineers would develop power from the ocean tides. That chimerical dream is about to be realized. A group of men in the East are planning the erection of a hydro-electric plant on the arm of the Bay of Fundy from which they expect to develop 600,000 hp. At this point, it seems, the entrance to the Bay, which has a combined area of about 150 sq. miles, is only a mile and a quarter wide, with a maximum depth of 175 ft. Hence the rise in tide is as much as 27 ft. In the erection of dams and control gates no strange engineering problems are involved so that there is nothing improbable about the conservative estimate that this project, when completed, will annually produce 3,000,000,000 kwh, or an amount of energy equal to 70 per cent of the total output of all the public utility plants in New England.

Other schemes, equally outstanding in importance, have been planned. One of them—the scheme for harnessing the power of evaporation—will be spoken of in these columns in an early issue. Their inception and development only bring home more forcibly the absolute importance of foresight and the realization that our profits for the ensuing 25 years will be dependant more upon increased productivity and decreased production costs than on lowered wage scales or cheaper raw materials.

Fuel Costs Cut

By J. B. Nealey*

Brass foundries which are a part of larger manufacturing plants have, for the most part, changed over from coal and coke firing, but when it is realized that nearly 90 per cent of the small jobbing foundries of the country are still addicted to the use of this fuel, the backwardness in this field is at once apparent. That this old-fashioned method of firing crucibles, should by this time, be obsolete, is universally conceded. This has been forcibly brought home recently by the disastrous effects of the coal strike in the anthracite regions, as this is the kind of coal required.

The fear of coal shortage from strikes, transportation, break downs and other causes is ever present, as few small foundries have storage facilities and rely on a single car load from time to time. And even providing they are able to obtain deliveries in times of labor troubles, transportation congestion, etc., sharply advancing prices throw foundry costs out of all proportion to outstanding contracts and bids, making losses inevitable. Aside from the unreliability of coal and coke supplies and costs, this method has many other disadvantages, not least of which is the obtaining of men who understand the proper way to melt metal in these pit fires. Furthermore labor is wasted every morning in chopping wood and making new fires and during the day much time is lost in continuously removing the furnace covers and feeding new fuel to the fires. This refueling is an ardous operation and difficult task and keeps many workmen away from brass foundries that would otherwise apply there for employment. The extra heat blast that is released when the furnace covers are removed also makes difficult the recharging of the crucible from time to time. The labor involved in bringing in the coal or coke and removing the ashes is also wasted. A large amount of metal is lost when the crucibles spill over and the metal drops down into the ashes, as metal thus spilled is never reclaimed by the average foundryman.

The A. C. Goldsmith Company of Newark, N. J., has recently installed a battery of gas fired, recuperative crucible furnaces which are giving great satisfaction. This furnace was developed by the Surface Combustion Company of New York after years of experimentation and has a burner of novel design and high efficiency. Air is raised to one or two pounds pressure by a pressure blower and gas at zero pressure is inspirated, the two being exactly and automatically proportioned for complete combustion which takes place in a refractory tunnel just prior to entering the furnace. The escaping hot gases are utilized in the recuperator to preheat the air to 900 or 1,000 deg. before it is mixed with the gas. Crucible pedestal troubles have been overcome in this furnace by using a special casting under the pedestal through which the cold air is passed before it enters the recuperator.

The first heat requires from an hour and twenty minutes to an hour and a half and thereafter the melting time is approximately 60 minutes. The melting speed of a gas fired crucible furnace is therefore much higher and in the same time it takes to melt three heats in the pit fired furnace, five can be melted in the gas furnace using cold air and from seven to eight with air heated in the recuperator. The fuel economies of the recuperators are evidenced by the fact that when melting red brass with cold air and gas the fuel consumption is about 500 cu. ft. per 100 lbs. of metal but when the incoming air is heated by the waste gases the fuel consumption is reduced to approximately 300 cu. ft. per 100 lbs. after the furnace has been heated to melting temperature. While the cost of gas varies little from the cost of coal there are many more advantages in favor of the former, not the least of which is a reduction in metal losses amounting to about 50 per cent due to the shorter time the alloy remains in the furnace.

With heat at a dollar per 1000 cu. ft. the cost of a pound of red brass of composition metal is about 3/10 cent. This cost varies somewhat and can even be lowered through properly synchronizing the melting and pouring. Conceivably it could be raised if the melts were not poured into the moulds as soon as ready just as an idling automobile engine wastes fuel.

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*Surface Combustion Company.

Increase in American Iron and Steel Trade in Japan

American iron and steel trade with Japan has shown more than a three-fold increase since prewar times, according to a trade bulletin made public today by the Commerce Department. Japanese import figures show that out of a total import of a 1,500,000 tons of iron and steel products in 1924, 320,000 tons, or 22 per cent, originated in the United States. In 1913 the total imports of these products were something over 800,000 tons of which this country furnished not quite 12 per cent. The remarkable industrial growth of Japan is apparent when the fact is taken into consideration that domestic production of pig iron and steel ingots increased many fold during this period.

A study of the bulletin discloses that our advance in the Japanese iron and steel market has been made largely at the expense of the United Kingdom and Germany. In the prewar year imports of iron and steel commodities from the former country made up 33 per cent of the total but this ratio had dropped to 22½ per cent in 1924. A comparison of German imports in 1913 and 1924 shows a 50 per cent decline in the latter year.

Owing to the steady industrial progress of the Japanese Empire it would appear that future imports of iron and steel products into that country will be in the nature of semi-finished articles to be fabricated in the domestic mills. However, it is stated that there will always be a market for the higher-grade American specialties.

Next to Japan, the report points out, the most promising markets for our iron and steel products are China, Chile, and Peru. All of these countries are in the process of industrial development and none of them have any tariff preferences.

The complete report, entitled "Iron and Steel Trade of the Pacific Area" by Marshall Teel Jones, Assistant Chief of the Iron and Steel Division, is published as Trade Information Bulletin No. 396. Copies may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district offices of the Bureau of Foreign and Domestic Commerce. The price is 10 cents.

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Current Literature on Ferrous Metallurgy

By E. H. McCLELLAND*

Accident to Woodward blast furnace. *Iron Age,* v. 117, Apr. 8, 1926, p. 987-988.

Algeria an important iron ore source. *Iron Age,* v. 117, Apr. 8, 1926, p. 986-987.

Annealing wire in salt bath. *Iron Age,* v. 117, Apr. 1, 1926, p. 928.

Application of the gas engine to the manufacture of iron and steel. J. E. James and C. Cook. *Iron and Coal Trades Rev.,* v. 112, Mar. 26, 1926, p. 525.

Atomic hydrogen used in welding. *Iron Age,* v. 117, Apr. 8, 1926, p. 989-991.

Bosshardt open-hearth furnace in foundry practice. *Iron and Coal Trades Rev.,* v. 112, Mar. 5, 1926, p. 394.

Centrifugally-cast pipes at works of the Stanton Ironworks Company, Limited. *Iron and Coal Trades Rev.,* v. 112, Mar. 19, 1926, p. 479-482.

Coke for blast-furnace purposes. Edgar C. Evans. *Iron and Coal Trades Rev.,* v. 112, Mar. 12-19, 1926, p. 425-426, 486-487.

Contraction of malleable castings. *Metallurgist,* Mar. 26, 1926, p. 38-39.

Conveyors nearly triple output; power-driven conveying systems are feature of improvements in continuous foundry; make 2000 Chevrolet cylinder blocks a day. F. L. Prentiss. *Iron Age,* v. 117, Apr. 8, 1926, p. 977-982.

Cutting tests of tool steels. Jerome Strauss. *Trans. A.S.S.T.,* v. 9, Apr. 1926, p. 571-584, 648.

Includes bibliography of thirty-three references to cutting tests of tool steels.

Design and operation of furnaces for salt baths. Sam Tour. *Trans. A.S.S.T.,* v. 9, Apr. 1926, p. 553-570.

Includes discussion.

Dilatomètre differentiel a enregistrement mecanique. P. Chevenard. *Rev. Mét.,* v. 23, Feb. 1926, p. 92-99.

Dilatometric method of heat treatment. O. E. Harder, R. L. Dowdell and A. C. Forsyth. *Trans. A.S.S.T.,* v. 9, Mar. 1926, p. 403-419.

Includes discussion.

Effect of manganese, silicon and phosphorus on the pearlite interval. B. Kjerrman. *Trans. A.S.S.T.,* v. 9, Mar. 1926, p. 430-451.

Elastic ring for verification of Brinell hardness testing machines. S. N. Petrenko. *Trans. A.S.S.T.,* v. 9, Mar. 1926, p. 420-429.

Appendix presents "Recommendations for Making a Brinell Test."

Electric control gear for iron and steel works. *Iron and Coal Trades Rev.,* v. 112, Mar. 5-26, 1926, p. 386-388, 428-430, 488-489, 526-528.

A fully illustrated article, containing 33 figures.

Electrically-produced blackheart malleable. F. A. Melmoth. *Iron and Steel of Canada,* v. 8, Dec. 1925, p. 255-258.

Fortschritte im elektrostahlschmelzen. G. Mars. *Giesserei-Zeitung,* v. 23, Mar. 1, 1926, p. 117-120.

Galvanizing an important operation in range boiler production. *Iron Trade,* v. 78, Mar. 18, 1926, p. 693-696.

Galvanizing of iron and steel. *Metallurgist,* Jan. 29, 1926, p. 9-10.

Abstract of paper by E. A. Atkins before Liverpool Engineering Society.

Hardening of steel; a review and some comments. W. T. Griffiths. *Metallurgist,* Mar. 26, 1926, p. 34-35.

Industrie der ferrolegierungen. Nikolaus Czako. *Giesserei-Zeitung,* v. 23, Feb. 15, 1926, p. 89-94.

Iron and steel manufacture in India. *Iron and Coal Trades Rev.,* v. 112, Mar. 26, 1926, p. 530-531.

Iron ore sintering spreads in East. E. C. Kreutzberg. *Iron Trade,* v. 78, Mar. 11, 1926, p. 641-643.

Large uses of steel in small ways; billboards. *Iron Trade,* v. 78, Mar. 11, 1926, p. 644.

Large uses of steel in small ways; bird cages. *Iron Trade,* v. 78, Mar. 25, 1926, p. 805, 807.

McEwen-Runge process of low-temperature carbonisation. David Brownlie. *Iron and Coal Trades Rev.,* v. 112, Mar. 26, 1926, p. 534.

Measurement as an aid to blast-furnace practice. *Metallurgist,* Mar. 26, 1926, p. 36-37.

Mélangeurs de fonte. E. Lepeytre. *Rev. Mét.,* v. 23, Feb. 1926, p. 82-91.

Navy and the steel industry. G. K. Spencer. *Iron Age,* v. 117, Mar. 25-Apr. 1, 1926, p. 831-833, 913-915, 964.

Non-corrodible nickel-chromium steels. *Metallurgist,* Feb. 26, 1926, p. 25.

Observations on the development and use of steel drying equipment in the ceramic industry. H. M. Schaab. *J. Am. Ceram. Soc.,* v. 9, Apr. 1926, p. 206-210.

Observations on temperature distribution in steel bodies cooled in air. E. J. Janitzky. *Trans. A.S.S.T.,* v. 9, Mar. 1926, p. 452-457.

On martensite. H. Hanemann and A. Schrader. *Trans. A.S.S.T.,* v. 9, Feb. 1926, p. 169-239.

Porosity of metals. *Metallurgist,* Mar. 26, 1926, p. 41-42.

Review of experiments by Tammann and Bredemeyer, described in *Zeitschrift fuer anorganische Chemie,* 1925.

Qualitative und wirtschaftliche bedeutung des sauren elektrostahles. Albert Müller-Hauff. *Stahl u. Eisen,* v. 46, Mar. 4, 1926, p. 289-294.

See illustrations on plates following p. 304.

Quarter century inaugurates age of steel. J. F. Froggett. *Iron Trade,* v. 78, Mar. 25, 1926, p. 764-768, 792.

Quarter century sees marked changes in foundries. D. M. Avey. *Iron Trade,* v. 78, Mar. 25, 1926, p. 782-784.

Reducing costs in heat treating automobile parts. *Trans. A.S.S.T.,* v. 9, Mar. 1926. p. 471-481.

Relationship of metallurgy to the development of aircraft. J. B. Johnson. *Trans. A.S.S.T.,* v. 9, Apr. 1926, p. 517-537.

Revolutionary changes are made in economics of blast furnace industry. G. H. Manlove. *Iron Trade,* v. 78, Mar. 25, 1926, p. 774-775, 793.

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*Technology Librarian, Carnegie Library of Pittsburgh.

Westinghouse Reorganizes Sales Department

E. H. Sniffin, former manager of the power department of the Westinghouse Electric & Mfg. Company, East Pittsburgh, effective April 2 became assistant to the vice president. In addition to the promotion of Mr. Sniffin, complete reorganization of the sales department involving the reallocation of the managing personnel and the creation of several new activities, was made known by E. D. Kilburn, vice president and general sales manager.

Also effective immediately the following changes are announced: Director of sales, T. J. Pace, formerly manager supply department; central station manager, G. H. Froebel, formerly manager marine department; industrial sales manager, J. M. Curtin, formerly manager industrial department; transportation sales manager, M. B. Lambert, formerly manager railway department; assistant director of sales, A. C. Streamer, formerly assistant to manager supply department; generating apparatus manager, H. W. Smith, formerly general engineer; traction apparatus manager, A. J. Manson, formerly manager heavy traction division, railway department; motor apparatus manager, O. F. Stroman, formerly assistant to manager industrial department; switchgear apparatus manager, R. A. Neal, formerly head of switch section, supply department; and distribution apparatus manager, G. A. Sawin, formerly assistant to manager supply department.

The announcement is the culmination of a reorganization of the Westinghouse sales system which has been in course of development for some time.

Controlled Prices Restored in Britain

After a year of free prices the Associated Steelmakers of England and Scotland have agreed to re-establish controlled prices for certain classes of steel. This step has been decided upon owing to keen price-cutting and the difficulty that makers have under present conditions of producing at remunerative levels.

For the domestic trade the price of ship-plates is fixed at £7-10s. (approximately $37.50) per ton—an advance of about 60 cents—and sections at £7 (approximately $35.00). Ship-plates for export are £7 per ton, but sections for export remain free. The makers are now members of the Steelmakers' Association, and it is believed that the present effort to keep the price at a profitable level will be more successful than has been the experience of the past.

Steelmakers on the north-east coast of England have for some little time past been adhering to the fixed price of £7-7s.-6d. (about $36.88) for steel plates and £7 for sections for the domestic trade, but for export there have been free prices and consequent price-cutting.

Institute Meeting Date

The American Iron and Steel Institute announces that its spring meeting will be held at the Hotel Commodore, New York City, on Friday, May 21. This date was selected because if the meeting were to be held on the fourth Friday of May, according to custom, it would fall too close to the Memorial day holiday.

To Unify Wire and Sheet Metal Gages

The elimination of the confusion caused by 30 wire and sheet metal gage systems now in use in this country is to be brought about as the result of a conference held on March 8, 1926, in the Engineering Societies Building, New York City, and attended by representatives of 25 organizations interested in all phases of the subject, which includes wires, sheets and tubes of metals of all kinds.

Unanimous decision was reached that the confusion in the purchase and sale, and in the use of these products, brought about by the existence side by side of the numerous conflicting gage systems, has become intolerable, and that industrial practice should be unified in a simple consistent plan. The detailed technical work will be in the hands of a sectional committee broadly representing all interested industrial groups and working under the auspices of the American Engineering Standards Committee.

The trend of opinion at the conference strongly favored the elimination of all gage numbers and the use of a simple system of designating sizes in decimals of an inch. The decision, however, on the exact form of the solution was left to the sectional committee, the scope of whose work was outlined as follows:

"The standardization of a method of designating the diameter of metal and metal alloy wire, the thickness of metals and metal alloys in sheet, plate and strip form and wall thickness of tubing, piping and casing made of these materials; and the establishment of a standard series, or standard series, of nominal sizes and of tolerances for wires, sheets, plates and strips."

Two Pipe Specifications Suggested

The American Society of Testing Materials, at a recent meeting in Providence of the Subcommittee on Steel Pipe, discussed a new plan of issuing steel pipe specifications. According to this plan the present Standard Specifications for Welded and Seamless Steel Pipe would be divided into two specifications, one covering the so-called standard pipe marketed principally through jobbers, and the other a pipe of special qualities suitable for bending, flanging and special purposes. The latter specifications are being drafted upon the basis of tightening the requirements in the present specifications and a number of revisions to this end were reported at the meeting. Progress is being made in the development of specifications for standard pipe.

Replacing Blast Furnace

Replacement of No. 2 blast furnace of the Republic Iron & Steel Company, in the Hazelton group has been started. The work which includes the razing of the present furnace was awarded the William B. Pollock Company. The new furnace will have a capacity of 750 tons per day.

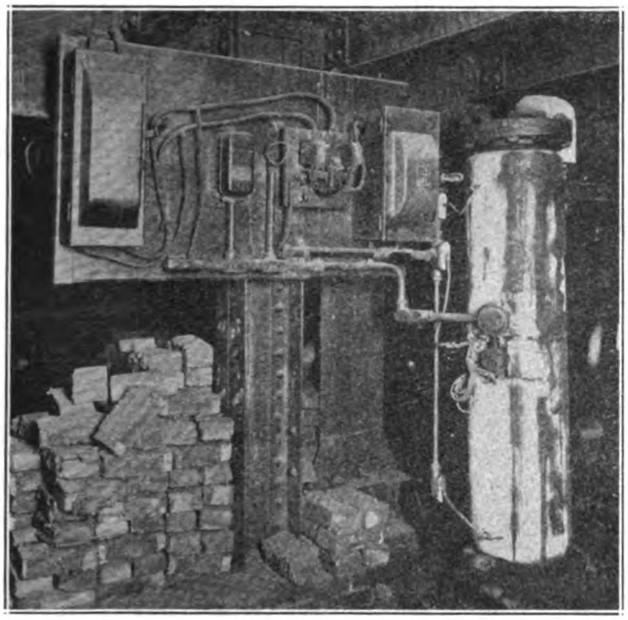
Stack Breaks Record

No. 2 blast furnace of the Youngstown Sheet & Tube Company at Indiana Harbor, Ind., the new stack which was placed in operation in March 1924, recently established a new record with an average production of 790 tons per day. No scrap was used in the charge and coke consumption was said to be remarkably low.

NEW EQUIPMENT SECTION

Preheating Fuel Oil, Electrically

The efficient combustion of fuel oil depends, to a certain extent, upon the maintaining of a constant fluidity of the oil at the burners. Fluidity, in turn, depends upon the temperature of the oil.



Electrically operated oil heater.

In the Phoenix Rolls Company two electrically heated oil heaters are used for preheating the fuel oil used in their open hearth furnaces. Each of these heaters consists of a cylindrical tank, 10 in. in diameter by 96 in. high. Thirty-two Westinghouse space heaters, arranged around the tank, heat the oil. The temperature is controlled by means of a bi-metallic thermostat mounted on the side of the oil tank, operating through a motor-operated snap-switch and a contactor. The oil, which is circulated by a motor-driven pump, enters the heater at the bottom and is removed from the top. The capacity of each heater is sufficient to heat 100 gallons of oil per hour to 180-210 degrees Fahrenheit.

On of the chief features of this method is that the control apparatus keeps the temperature of the oil at the desired point without any attention on the part of the operators; through their use more efficient combustion in the open hearth furnaces is obtained and economical saving effected.

Globar Heating Elements

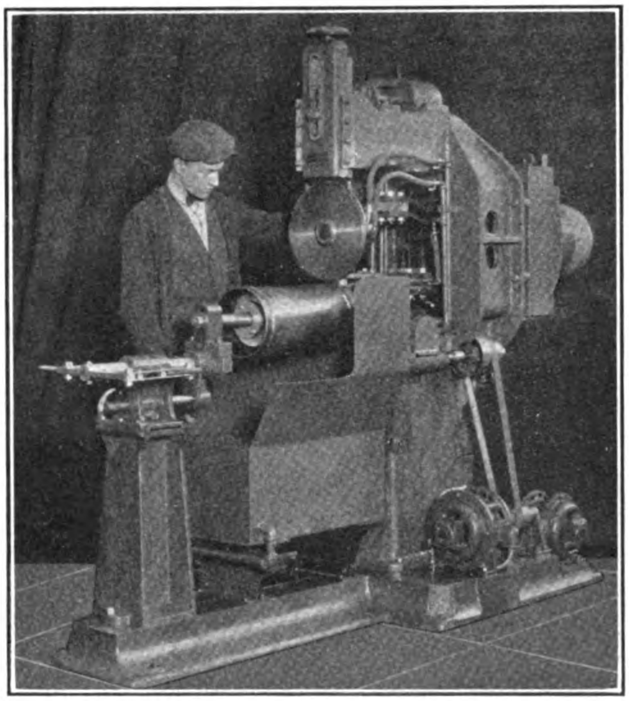
The American Resistor Corporation has recently placed on the market "Globar" non-metallic heating elements in diameters up to 1⅝ in. and 2 in. The maximum diameter heretofore has been ¾ in. and the increase in available diameters offers a means of securing greater kilowatt capacity per unit and hence fewer units are required in any one furnace application.

New Resistance Welders

The latest extension in General Electric welding activities is the entry into the resistance welding field. That company is now marketing two automatic resistance welding machines, one for straight seam work and the other for circular seams.

In resistance welding fusion is effected by heat generated by passing an electric current through the materials to be welded, augmented by pressure, whereas arc welding utilizes an arc or flame to melt the work, electrode or both. The General Electric automatic resistance welders consist of a framework for holding the work, a transformer for supplying current to the electrodes, movable electrode wheels and necessary control.

These equipments were particularly designed for welding the seams of light metal container such as ice cream cans, drums, etc., and are suitable only for making lap joints with relatively thin metal. Among the advantages are the absence of fumes and open arcs making the use of masks unnecessary, and the fact that the operator requires no special training.



Automatic resistance welding machine.

The welding speed obtained with these equipments varies from approximately 20 inches per minute to 100 inches per minute, depending on the nature and thickness of the material to be welded. Material up to a total thickness of ¼ inch may be accommodated.

A recent installation of this equipment is in the plant of the Solar-Sturges Company of Chicago, where the circular seams of ice cream cans will be welded by this process.

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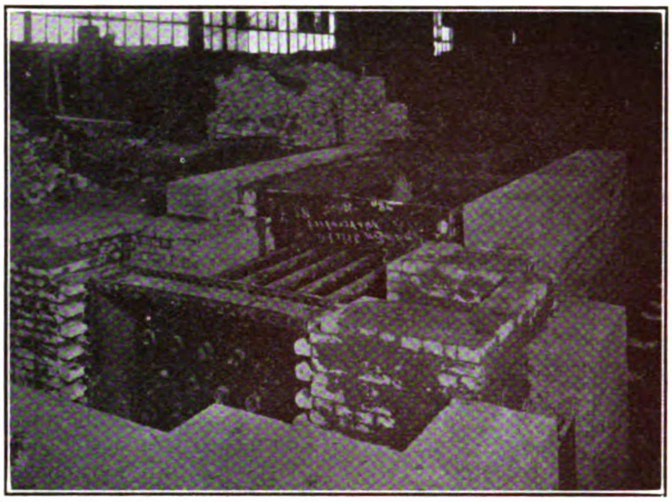
Ludlum Building Continuous Billet Furnace

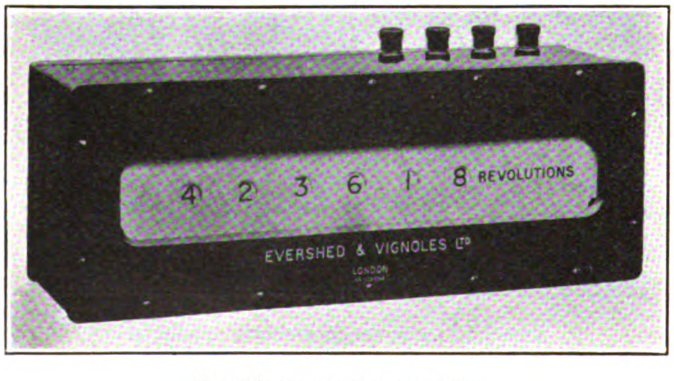
The Ludlum Steel Company, general offices and works, Watervliet, N. Y., are building a continuous furnace of very modern construction and design for billet heating. In the recuperative equipment is employed Ludlum's own heat and scale resisting material. It will be noted that their famous Delhi Tough is used in tube form in this equipment. This is but one of many improvements being made at the Ludlum plant.



Continuous billet heating furnace.

An Electric Revolution Counter

A revolution counter manufactured by Evershed & Vignoles, Ltd., London is designed for the purpose of counting revolutions or other operations at any distance from the machinery. For revolutions up to 400 a minute it is made to count single revolutions, but if it is required to count at a higher speed than this the transmitter is geared down from the revolving machinery so as to count one in every 10 revolutions.



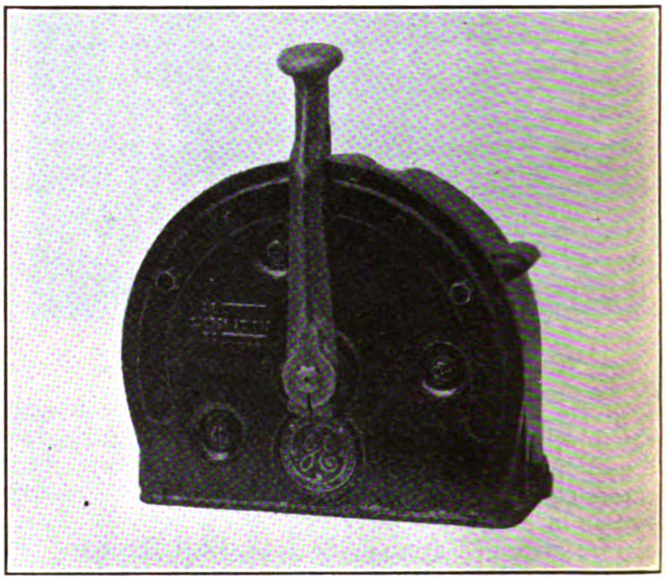
Electric revolution counter.

The counter has the appearance of an ordinary mechanical counter but the working parts are designed on an entirely new principle. It is combined with a step-by-step motor, driven by electric current derived from an ordinary light socket. The counter consists of a number of dials, each of which is arranged to be locked mechanically in any of ten positions corresponding to the numbers 0 to 9, but mechanically entirely independent except during the time when a change of indication is in progress. This magnetic lock enables each unit to be free from friction. The step-by-step motor is novel in that while it provides ample power for moving the counter its construction is light enough to work with certainty up to speeds not exceeding 400 a minute.

New Master Switch

A new lever operated master switch for steel mill service or other work where exceptional strength and durability are important factors is now announced by the General Electric Company. The new switch is particularly suitable for grouping and for operation by one man. It has been assigned the designation C-3003 in the CR-3012 series of control.

The C-3003 master is flat and semicircular in general shape, consisting of a cast iron frame and cover totally enclosing the contact mechanism. This design readily permits convenient grouping within easy reach of one operator. The handle is of the vertical type, operating through a radius of 40 deg. on a one-point switch and through a 100 deg. total radius on the three-point switch. This handle is mushroom shaped so that it may be grasped easily and quickly. Operation from one position to another is very free, there being no gears or other friction surfaces other than the bearings and contact fingers. The handle is held in the "off" position by a spring roller device.



Master switch for steel mill service.

This switch is made in several forms, the C-3003-B being standard.

Mill Contract Awarded

Morgan Construction Company, Worcester, Mass., has been awarded a contract for billet and rod mills for the South works of the American Steel & Wire Company, Worcester, which is to be entirely replaced by a new plant. Production will not be interrupted by the change, which is being made to decrease production cost and improve quality. Output will not be increased. Electric motors will replace the present steam motive power.

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This is a book on the one hand for the steel works staff and managers, on the other hand for technical and higher grade students.

The book opens with a short history of the Siemens-Martin process, and after outlining the metallurgical theory, consideration is given to the layout of steel works and the detailed examination of the work which each section has to perform Numerous plans point the moral and emphasize the difference between good and bad practice, for the question of economy in transport is intimately involved.

Those concerned with the design and working of melting furnaces will find here invaluable data and comparison. Important sections on producers, charging machines, crane arrangements, waste-heat boilers and all those secondary improvements which can determine the balance between profit and loss, follow.

CONTENTS—Introduction: Historical and Statistical Data on the Open Hearth Process. The Metallurgical Principles of the Open Hearth Process. The Location of the Steel Works in Relation to Other Plant; Supply of Raw Material; Supply of Liquid Iron; Provision of Heat; Removal of the Products; Railway Sidings. Relative Location of the Individual Departments: Raw Material and Furnace Material Stores; Transverse Sections of the Open Hearth Steel Works; Various Bays of the Steel Works. Details of Equipment; Buildings; Furnaces; Gas Producers; Auxiliary Machinery. Arrangements and Efforts to Improve the Thermal Efficiency of Open Hearth Steel Works: Recovery of Tar from the Gasification Plant; Application of Richer Gases; Waste Heat Boilers; Supervision of the Thermal Efficiency. The Duplex and Triplex Processes—Present Applications and Prospects. Bibliography. Index.

Rapid Methods for the Chemical Analysis of Special Steels, Steel Making Alloys and Graphite

Johnson

By Charles Morris Johnson, Chief Chemist and Director of Research Department, Park Steel Works, Crucible Steel Company of America. Third edition, revised, 552 pages, 6x9, 70 figures, cloth. $6.00.

An unusually thorough revision, including all of the important new metals as well as new methods for the analysis of older ones. Anyone who knows general chemistry can follow the author's instructions and get real results.

Acid-Resisting Metals

Tungay

Charts, tables, 4¾x7½, cloth, 136 pages. $2.00.

Comprising information of assistance to those faced with works problems in connection with the selection of suitable metals for construction of plant intended to resist the action of corrosive liquids and gases. Much experience gained during the European War and during the post-war years in Great Britain is here published for the first time.

CONTENTS—Acid-Resisting Metals; High Silicon Iron or Acid-Resisting Iron; Lead and Regulus Metal; Aluminum; Stainless Steels; Monel Metal; Cast Iron and Steel; Nickel and Chromium Alloys; Copper and Copper Alloys.

Technical Analysis of Steel and Steel Works Materials

Sisco

543 pages, 6x9. $5.00.

The aim of the book is fivefold: 1. To give to the routine analyst who hopes to advance, the best known methods for the analysis of special steels and steel works materials and a bird's-eye view of the problems encountered in operating a routine laboratory. 2. To emphasize the need of speed in analytical control. 3. To give the industrial chemist the best, simplest and most rapid methods for the analysis of any sample of steel or steel works materials that he may encounter. 4. To give to the college student in metallurgical chemistry the methods of steel analysis with emphasis on, not how the work should be done, but how it is done, in the works laboratory. 5. To give to the steel worker, from furnace helper to general superintendent, an account, readily comprehended, perhaps, of the steel laboratory and its problems.

Iron and Steel

Tiemann

New second edition, 514 pages, flexible pocket size, illustrated. $4.00.

This is a dictionary, an encyclopedia, a hand-book on iron and steel all in one. The metallurgist, the mill superintendent, and the salesman will find it of daily use. The book presents nearly 8,000 terms and definitions of processes and equipment so arranged that you can find exactly what you want quickly. It brings together and translates the varied nomenclature of the mill, the laboratory and the office. For those who use steel, for those who manufacture steel and steel products, and for those who sell steel, it is a valuable guide to the necessary information as to processes and methods. This new second edition is almost twice as large as the first edition. The chief increase in the text is due to more extended discussions of subjects, such as heat treatment, physical propertes, and testing, and to numerous investigations of the more theoretical aspects of the subject, particularly those included under metallography.

Metallurgy of Iron and Steel

Stoughton

New third edition, thoroughly revised, 248 illustrations, 576 pages, 6x9. $4.00.

A thorough treatment of the characteristics, metallurgy and production of iron and steel. For many years this book has been the standard guide for engineers, metallurgists, chemists, foundrymen, and iron and steel plant executives. Much new material has been added to the chapters on Mechanical Treatment, Foundry, Constitution of Iron and Steel, and Heat Treatment. This book is essentially a handbook on the characteristics and production of iron and steel in all its phases.

Microscopic Analysis of Metals

Osmond and Stead

Third edition, revised and corrected by L. P. Sidney. 313 pages, 8vo., cloth. $4.00.

The new edition of this extremely valuable book is now in preparation and comprises features which render it thoroughly up to date in every respect. It is very beautifully illustrated with 195 photomicrographs, diagrams and figures and covers such important subjects as Anatomical Metallography, Biological Metallography, and Pathological Metallography, also the Science of Polishing, Grinding, etc., the Micrographic Analysis of Carbon Steels, the Micrographic Identification of the Primary Constituents of Carbon Steels, the Detailed Examination of Selected Steels, the Segregation in Steel and the Phenomena of Burning, Overheating, etc.

Electric Furnaces in the Iron and Steel Industry

Rodenhauser, Schoenawa, Vom Baur

Dr. Dipl. Ing. W. Rodenhauser, E.E., and J. Schoenawa. Translated from the original and rewritten by C. H. Vom Baur, E.E., formerly Chief Engineer, American Electric Furnace Company. Third edition, revised, 460 pages, 133 figures, two full-page plates, cloth. $4.50.

Thoroughly describes electric furnaces designed solely for the iron and steel industry, written from a practical standpoint by practical men. Deals first with the construction and the appartus, and second, with the practical use of furnaces and their metallurgical reactions.

Fuels and Their Combustion

Haslam and Russell

By Robert T. Haslam, Professor of Chemical Engineering, and Robert P. Russell, Assistant Professor of Chemical Engineering, Massachusetts Institute of Technology. 809 pages, 6x9, 304 illustrations. $7.50.

In order to give the reader the proper viewpoint, the first subjects treated are the origin, composition and production of the natural fuels, coal, petroleum and natural gas. In the chapters devoted to combustion equipment, representative types are described as illustrative of modern design. The interpretation of combustion data depends on calculations based on the common combustion reactions and this phase of the subject is presented in considerable detail. Secondary or manufacturer fuels, producer, water, oil and coal gas, are given special prominence in view of their rapidly growing importance. Since the flow of air and flue gases and heat transfer are inseparably connected with the capacity and efficiency of combustion equipment, the book concludes with three chapters dealing with these subjects.

CONTENTS—The Fuel Situation. Origin and Composition of Coal. Types of Coal and Their Classification. Spontaneous Combustion and Storage of Coal. Coal Resources and Coal Production. Petroleum. Other Primary Fuels. The Chemistry of the Combustion Reactions. Combustion of the Elementary Fuels. Combustion Calculations. Properties and Combustion of Gaseous Fuels. Combustion of Coal on Grates. The Operation of Hand-Fired Furnaces. Mechanical Stokers and Furnaces. Powdered Coal. The Combustion of Fuel Oil. Furnace Efficiency and Distribution of Heat Losses. Producer Gas. Water Gas and Oil Gas. The Carbonization of Coal. Flow of Liquids and Gases. Flow of Heat. Rate of Heating.

Materials Testings—Theory and Practice

Cowdrey and Adams

By Irving H. Cowdrey, Assistant Professor of Testing Materials, and Ralph G. Adams, Instructor in Mechanical Engineering, Massachusetts Institute of Technology. 129 pages, 6x9, 51 illustrations, cloth. $1.50.

This book gives a concise presentation of the methods and the fundamental theory of the testing of materials of construction, with condensed specifications and properties of the more common ones. A study of the test will lead to a clearer understanding of specifications, and will be of assistance in the interpretation of the results of physical tests.

CONTENTS—Province of the Testing Engineer. The Report. Testing Machines. Tensile Tests. Graphs. Compressive Tests. Torsional Tests. Transverse Tests. Dynamic Tests. Test Specimens and Holders. Fractures and Their Significance. Hardness Determination. Cement Testing. Testing of Sand. Timber Testing. Measuring Devices. Verification of Testing Machines. Appendix.

Send order and remittance to BLAST FURNACE AND STEEL PLANT

Book Department—Box 65, Pittsburgh, Pa.

PERSONALS

Burt Fleeger, formerly treasurer, sales manager and a director of Sivyer Steel Casting Company, Milwaukee, has resigned to become vice president, Oklahoma Steel Castings Company, Tulsa, Okla. Mr. Fleeger had been with the Sivyer organization since 1913. He has acquired a substantial interest in the Oklahoma company, and established headquarters in Tulsa, March 25.

* * *

P. E. Floyd has been appointed manager of sales in charge of the Chicago office and warehouse, Ludlum Steel Company, Watervliet, N. Y., succeeding H. W. Edwards, transferred to southern territory with headquarters at Houston, Texas.

* * *

G. F. Murray, for many years with Naylor & Company, New York, and more recently with the foreign trade department, Rogers, Brown & Company, has become manager of the ores and metals department, Bowring & Company, New York.

* * *

Alfred E. Gibson, for the past five years general superintendent of the Cleveland and Akron works of the Wellman-Seaver-Morgan Company, has resigned to become vice president and director, Fulton Foundry & Machine Company, Cleveland. Mr. Gibson entered the Wellman-Seaver-Morgan Company works as a machinist apprentice, soon was made superintendent of all departments, and in 1921 became general superintendent.

* * *

R. H. Shirk, for the past six years assistant general manager of sales, Lancaster Steel Products Corporation, Lancaster, Pa., has become identified with the general sales office of the Union Drawn Steel Company, Beaver Falls, Pa.

* * *

Frank H. Colladay has been appointed district sales manager in New York for the Braeburn Alloy Steel Corporation. He was formerly associated with the Trumbull Steel Company.

* * *

John K. Desmond, formerly connected with the Philadelphia district sales office of the Crucible Steel Company of America has been appointed Philadelphia district manager of steel sales for Henry Disston & Sons, Inc., Tacony, Philadelphia, Pa.

* * *

F. H. Burnett, formerly assistant to the general manager of the Lackawanna plant, Bethlehem Steel Company, Lackawanna, N. Y., has been appointed claim agent for the company, with headquarters in the general offices at Bethlehem, Pa.

* * *

Samuel Muir, formerly assistant superintendent, open hearth department of the Donner Steel Company, Buffalo, has succeeded Kent Harrison as open hearth superintendent.

Prof. C. W. Beese has been appointed head of the Department of Industrial Engineering at Pennsylvania State College.

* * *

E. C. Collins has resigned as president of the Crucible Steel Company of America. It is probable that the office will remain unfilled until after the annual meeting of the company in the latter part of April.

* * *

Thomas D. Graham, who has been attached to the New York office of the Republic Iron & Steel Company, has resigned to become Cleveland district sales manager, Reading Iron Company.

* * *

W. C. Peterson has been appointed metallurgical engineer for the Donner Steel Company, Inc., Buffalo, N. Y., with his headquarters at Detroit. Mr. Peterson for many years was in charge of the metallurgical department of Packard Motor Car Company and for the past two years has been a consulting engineer with offices at Detroit.

* * *

J. C. Woodson, former section engineer in charge of industrial heating, has been appointed manager of the industrial heating engineering department of the Westinghouse Electric & Manufacturing Company. Mr. Woodson, a graduate of Oklahoma State University, entered the service of the Westinghouse Company in 1915. After about a year's training in the shop he was assigned in 1916 to the circuit breaker section of the Supply Engineering Department. In 1920 he entered the industrial heating work and has been engaged in this work ever since.

* * *

O. C. Sheldon, formerly located at Worcester, Mass., as advertising manager of the Riley Stoker Corporation, has been transferred to the Cincinnati office of that company as district manager.

* * *

Avery Adams has been appointed assistant general manager of sales of the Trumbull Steel Company, Warren, Ohio. Mr. Adams succeeds Arthur Long, who recently became identified with the Youngstown Sheet & Tube Company.

* * *

Charles Kandel has been appointed sales manager of the International Oxygen Company, Newark, N. J.

* * *

David S. Hays has been made superintendent of the open hearth works of the Edgar Thomson plant, Carnegie Steel Company, Pittsburgh. Mr. Hays, who was assistant superintendent of the open hearth department at the Homestead works of the Carnegie company, succeeds John W. Kagarise, resigned.

* * *

Arthur M. Long has become identified with the Youngstown Sheet & Tube Company and will have charge of tinplate sales when the company's new Indiana Harbor plant is completed. Mr. Long was associated with the Jones & Laughlin Steel Corporation in its Chicago office, resigning in November, 1917, to join the sales organization of the Trumbull Steel Company. Until April 1 he was manager of sales, sheet and tinplate division of the Trumbull Steel Company, Warren, Ohio.

* * *

Harry Heffrin, formerly of the Kittanning Iron & Steel Company, Kittanning, Pa., has just been appointed blast furnace superintendent in charge of operations of the top furnace department of the Wheeling Steel Corporation, Wheeling, W. Va. He succeeds W. J. Huge, resigned.

* * *

M. P. Regan, department superintendent Republic Iron & Steel Company, Youngstown, has resigned to become superintendent of the Struthers Furnace Company, operating a merchant blast furnace at Struthers, Ohio. Mr. Regan succeeds Jules Richards.

* * *

George L. Gordon has been appointed general manager of sales of the Lukens Steel Company, plate manufacturers, Coatesville, Pa., and will assist his brother, Frank H. Gordon, who is general manager of sales.

OBITUARIES

Herbert W. Cheney, for many years associated with the Allis-Chalmers Manufacturing Company as electrical engineer, died at his home in Milwaukee on March 23.

* * *

Alexander Blaser, welding and cutting expert for the Air Reduction Sales Company, of New York, died at his home in Union City, N. J., on March 24. He was 41 years old.

* * *

H. Benson Wiese, secretary of the Parkesburg Iron Company, Parkesburg, Pa., died of heart trouble at his home there March 29, after an illness of nine months.

* * *

Clarence Price, formerly vice president and director of the American Car & Foundry Company, New York, died April 2 at his home there.

* * *

John Joseph Charles, president of Hibbard, Spencer, Bartlett & Company, Chicago, died at Pasadena, Cal., April 6th.

* * *

Capt. Benjamin Rockafellow, cousin of John D. Rockefeller and pioneer in Colorado mining, died March 29 at the age of 91. Captain Rockafellow developed mines which later became holdings of the Colorado Fuel & Iron Company.

* * *

August Thyssen, one of the dominating figures of the Ruhr iron and steel industry, and a leading industrialist of Germany, died April 4 at his Lindsborg castle near Muehlheim. He died aged 86, of pneumonia, following an operation on his eyes.

TRADE NOTES

Globe Seamless Tube Company, Milwaukee, has completed installation of much new equipment in its plant and is considering plans for adding machinery to increase its output further.

* * *

Sharon Steel Hoop Company, Sharon, Pa., has reelected Severn P. Ker president, H. T. Gilbert, T. P. Draper and L. W. Smith vice presidents, and J. Reid Evans secretary and treasurer.

* * *

Steel coal mixing bins are being installed over the by-product coke ovens at the Zenith Furnace Company, West Duluth, Minn., replacing the wooden structure which was damaged by fire recently.

* * *

The Combustion Utilities Corporation, Steneck Trust Building, Hoboken, N. J., manufacturer of fuel saving devices, oil burners, temperature control appliances, and steam, plumbing and electrical specialties, has been incorporated. No expansion of the company's facilities is contemplated at present.

* * *

Contract has been let by John Hassell, Inc., Clay and Oakland Streets, Brooklyn, manufacturer of rivets, wire nails, etc., to the Barney-Ahlers Construction Company, 110 West Fortieth Street, New York, for a three-story addition, 75 by 100 ft., to cost $100,000 with equipment.

* * *

The Transue & Williams Street Forging Corporation, Alliance, Ohio, plans the construction of a one-story factory addition, 80 by 240 ft.

* * *

Republic Iron & Steel Company has moved its Chicago office from room 1008 to room 561, 332 South Michigan Avenue.

* * *

Watson Brothers Steel Company, 2001 Vulcan Street, Detroit, has completed an addition to the plant which more than doubles its size. The company is carrying a warehouse stock of black and galvanized sheets and automobile body sheets and, as a selling organization, operates throughout the state. It has been in business a little more than two years.

* * *

The Niles Tool Works Company division and the Pratt & Whitney Company division of the Niles-Bement-Pond Company has moved the Cleveland office and sales room from West Superior Avenue to 1433 East Twelfth Street.

* * *

The St. Louis Pressed Steel Company, East St. Louis, Ill., manufacturer of stampings, has changed its name to the Key Boiler Equipment Company.

* * *

James Howden & Company, Wellsville, N. Y., manufacturer of air preheaters for furnaces and boilers, has changed its name to the Air Preheater Corporation.

The Milwaukee Electric Crane & Manufacturing Corporation, Milwaukee, opened an office at 11 South LaSalle Street, Chicago, in charge of Byron B. Evans.

* * *

The Bridgeport Chain Company, Crescent Avenue, Bridgeport, Conn., manufacturer of steel and iron chains, has awarded a general contract to the T. J. Pardy Construction Company, 1481 Seaview Avenue, for a one-story addition, 40 by 82 ft.

* * *

The Edward G. Budd Manufacturing Company, Twenty-fifth Street and Hunting Park Avenue, Philadelphia, manufacturer of steel automobile bodies, has acquired 49 per cent of the capital stock of the Ambi-Budd Presswerke, G. M. B. H., Berlin, Germany, recently formed as an affiliated organization with the officials of the Ambi Company, Berlin.

* * *

James W. Fuller, Jr., formerly one of the heads of the Fuller-Lehigh Company, Catasauqua, Pa., manufacturer of pulverizing and pumping machinery, etc., recently purchased by the Babcock & Wilcox Company, 85 Liberty Street, New York, boiler manufacturers, has organized the Fuller Company. It will specialize in the manufacture of patented conveying systems previously produced by the Fuller-Lehigh Company but not included in the sale of that organization.

* * *

The Conemaugh Iron Works, Inc., Blairsville, Pa., is resuming operations following reconstruction after a fire last fall which caused a damage estimated at $400,000. The new plant consists of a three-story machine shop and pattern shop, 60 by 75 ft., one-story foundry, 65 by 312 ft. The company specializes in the production of enameled iron sanitary ware, and will give employment to more than 400.

* * *

A. F. Stengel of Buffalo, N. Y., recently associated with the Rogers Brown Company and later with Waldo, Egbert & McClain, has become connected with the Mystic Iron Works, Boston, Mass., and will head the sales organization.

* * *

Crucible Steel Casting Company, Milwaukee, will start production in its new foundry about May 15, with capacity of 400 tons per day, doubling the output of its former plant. The old foundry will be placed on the market when the new plant is occupied. Equipment will include two electric furnaces and complete electric annealing equipment.

* * *

Western Metal Specialty Company, Milwaukee, Wis., manufacturer of automotive and industrial stampings, sheet metal products and freight car heaters, has started a new warehouse which will be used to increase production of automotive sheet metal products. The Western Company has just received a large contract from the General Motors Corporation for automotive stampings.

* * *

Ohio Electric & Controller Company, Cleveland, has appointed Railway Power & Engineering Corporation, Ltd., 133 Eastern Avenue, Toronto, Ont., and Industrial Supply Company, Brown-Marx Building, Birmingham, Ala., as sales representatives.

Mystic Iron Works, Everett, Mass., is nearing completion of its blast furnace plant, and officials expect operations to start within 60 days. The site is on Boston harbor directly across the Mystic river.

* * *

Connors Steel Company, Birmingham, Ala., manufacturer of cotton ties, steel hoops and light bands, is building a plant to produce rail carbon reinforcing bars, light angles and flats.

* * *

American Manganese Bronze Company, Philadelphia, has reorganized and consolidated its organization under one management, T. H. Addie, vice president and treasurer, being elected president and general manager. He has been an officer of the company since 1914 as executive and metallurgical engineer. The company specializes in propeller wheels, water turbine runners and bronze castings and forgings, and acid-resisting alloys and acid valves.

* * *

Crucible Steel Company of America has moved its New York sales office and warehouse from 420 Canal Street to larger quarters at Dominick and Clark Streets. W. P. Knecht has recently been appointed office manager.

* * *

Strong-Scott Manufacturing Company, Minneapolis, manufacturer of powdered coal combustion equipment, has appointed George W. Heald, 53 West Jackson Boulevard, Chicago, its sales representative in that territory.

* * *

Homestead Valve Mfg. Company, Homestead, Pa., announces that George H. Fredericks & Company, 216 West Water Street, Milwaukee, Wis., has been appointed as their agent in Milwaukee and the surrounding territories to handle the full line of Homestead products.

* * *

The Pennsylvania Engineering Works of New Castle, Pa., announce the establishment of a complete welding department, with facilities for all kinds of light and heavy work. R. H. Banks, located at 530 Union Trust Building, Pittsburgh, Pa., is in charge of sales. Production of iron castings has been resumed in their foundry, after suspension of operations for repairs and improvements. The foundry has a capacity of 1,000 tons per month of gray iron and semi-steel castings from 10 pounds to 50 tons.

* * *

The Hardware Specialty Manufacturing Company, a new firm recently incorporated under the laws of Ohio, has purchased and is now operating the plant formerly known as the F. J. Shively Company, located at 118 Seventh Street, S. W., Canton, Ohio.

* * *

Link-Belt Company of Chicago, Indianapolis and Philadelphia, have recently announced that Mr. Nelson Brandt has rejoined their sales management force and that he will manage a new branch office which is to be opened up in Florida.

* * *

American Engineering & Sales Corporation announces the opening of its offices at 1317 F Street, N. W., Federal American National Bank Building, Washington, D. C.

The Rollway Bearing Company, Inc., Syracuse, N. Y., manufacturer of heavy duty roller bearings for radial and thrust loads, announces the following changes in personnel of their sales force: C. A. Call, formerly assistant sales manager, Gurney Ball Bearing Company, has been appointed sales manager. E. J. Lybert, formerly representing the Rollway Company in the Philadelphia district, now takes charge of the Detroit district. J. D. Firmin, for many years associated with the engineering department of Niles-Bement-Pond, is now engineering representative in the Philadelphia district. W. E. Smith has been transferred from the home office to the Youngstown district where he will assist Samuel Farrell, district representative. S. J. Kaiser continues to represent the company in the Chicago territory.

* * *

The American Locomotive Company, 30 Church Street, New York, has announced intentions of discontinuing operations at its Paterson, N. J., plant, effective May 1. Work on hand at that time will be transferred to other plants of the company, including the works at Schenectady, N. Y.

* * *

The Shaw-Walker Company, 27 Division Street, Muskegon, Mich., manufacturer of sectional bookcases, filing cabinets, etc., has asked bids on a general contract for a five-story and basement addition, 80 by 200 ft., to cost about $250,000 with equipment. Albert Kahn, Marquette Building, Detroit, is architect and engineer.

* * *

The Tennent Steel Casting Company, Tacoma, Wash., is considering the construction of a new one-story foundry to cost about $80,000 with equipment.

TRADE PUBLICATIONS

Power Hammers — Barbour-Stockwell Company, 205 Broadway, Cambridge, Mass., has issued a catalogue illustrating and describing Dupont power hammers. Complete specifications are given for both the belt and motor-driven styles.

* * *

Hardening Equipment—Leeds & Northrup Company, 4901 Stenton Avenue, Philadelphia, Pa., has issued a circular entitled "Exact Hardening With Simple Equipment", dealing with the Hump method of hardening and showing Hump electric hardening furnaces and equipment.

* * *

Electric Fittings—Crouse-Hinds Company, Syracuse, N. Y., describes their safety "Arktite" plugs and receptacles, interlocking switches and plugs, and safety hand lamps in Bulletin 2086. Bulletin 2085 contains data on conduits for grounding service wire and conduit system.

* * *

Recording Instruments—"Do You Use Your Plant Newspaper" is the title of a 24-page booklet recently published by the C. J. Tagliabin Mfg. Company, Brooklyn, N. Y. This booklet presents in an interesting manner the value of recording instruments in general.

Threading Die-Heads—Geometric Tool Company, New Haven, Conn., is distributing a pamphlet on the subject of thread standardization, descriptive of a movement to simplify practice in cutting screw threads by standardization of the sizes of die-head chasers. The pamphlet lists all sizes of chasers regularly carried in stock, all other sizes being furnished at an extra charge covering the expense incidental to manufacturing in small quantities.

* * *

Furnace Linings—The use of the Quigley Refractory Gun for quick repairs and maintenance of furnace linings, including hot patching and surface coating is described in a 12-page booklet being distributed by the Quigley Furnace Specialties Company, Inc., New York.

* * *

Mine Pumps—The selection and application of centrifugal pumps to mine pumping is the subject of a 20-page leaflet distributed by the De Laval Steam Turbine Company of Trenton, N. J. Instructions are given for the design of piping, and the calculation of friction head power required. Details of construction which should be looked into when selecting pumps for this service are also discussed at length. This publication should be useful not only to mine owners and engineers, but to anyone using pumps for irrigation, general water supply, and similar service.

* * *

Air Compressors—Bulletin No. 127 being distributed by the Pennsylvania Pump & Compressor Company, describes their direct-connected synchronous motor driven air compressors.

* * *

Welding and Cutting Equipment—A 12-page booklet published by the International Oxygen Company, Newark, N. J., describes the cutting and welding torches and accessories.

* * *

Spray Cooling—Spray Cooling is the title of catalog N-613 published by the Yarnall-Waring Company, featuring Yarway type B Involute spray nozzle with conical orifice and special fittings for spray cooling pond installations.

* * *

Gas Producers—Bulletin No. 84, 48 pages, published by the Wellman-Seaver-Morgan Company, Cleveland, Ohio, describes the construction and operation of their type-L gas producer. This bulletin is beautifully illustrated with half-tones and blue prints and also contains many tables showing analyses, gasification values, comparison of fuels, operating costs, etc.

* * *

Liquid Fuel Valve—William M. Bailey Company, 508 Bakewell Building, Pittsburgh, has issued a bulletin describing its regulating valve for accurate, measured regulation of flow of fuel oil, tar, water and other liquids. Minute adjustment of orifice through a special form of needle valve and orifice gives a close degree of adjustment of liquid passing the valve.

* * *

Refractories—Fire brick designed to resist the destructive efforts of various factors of service are featured in a leaflet by the Ashland Fire Brick Company, Ashland, Ky.

Electric Motors—The General Electric Company, Schenectady, N. Y., has published a booklet, GEA-232, entitled "Power Factor and Means for Its Improvement". The booklet has 33 pages, illustrated with half tones and diagrams, and gives in a simple and systematic manner a fund of information on the methods of improving the power factor in industrial plants. It is a treatise on the power factor with all calculations reduced to simple arithmetic.

* * *

Flasks—Steel flasks of various sizes and forms are illustrated in the catalog recently mailed by the Shanafelt Manufacturing Company, Canton, Ohio. The flasks are of one piece welded construction and are built for heavy duty.

* * *

Steel Sash—Continuous sash for the modern well-lighted shop is described in the catalog published by David Lupton's Sons Company, Philadelphia. Methods of manufacture, types and roof design also are shown.

* * *

Transportation—A discussion of man power and mechanical means of moving materials through the shop is contained in a booklet issued by the Clark Tructractor Company, Buchanan, Mich.

* * *

Scleroscope—Shore Instrument & Mfg. Company, Jamaica, N. Y., presents a full description of the construction and operation of its direct-reading scleroscope, with discussion of the advantages of this type of testing equipment.

* * *

Forced Draft Stokers—Combustion Engineering Corporation, Broad Street, New York, has published a 16-page catalog of Green stokers for free burning bituminous or lignite coal. This is a chain grate type, with horizontal fuel bed, and is shown in a variety of settings under steam boilers, some of which feature the Dutch oven.

* * *

Micarta Gear Ratings—Westinghouse Electric & Mfg. Company, East Pittsburgh, in its publication C-1579-D, describes a change in the computation of the horsepower ratings of Micarta gears, based on the use of a fibre stress figure of 6,000 lb. in place of 5,000 lb., previously used.

* * *

Switches—Westinghouse Electric & Mfg. Company, has published its leaflet 25403 describing the design and engineering specifications of its types R and RA disconnecting switches. Besides several illustrations there is a table showing the outdoor shell-type insulator assembly ratings.

* * *

Steam Turbine Instrument—The Uehling Instrument Company, 473 Getty Avenue, Paterson, N. J. are distributing a new catalogue, No. 150, covering their combined barometer and vacuum recorder for use with steam turbines. This instrument records the absolute back pressure of the turbine exhaust, that is the true vacuum corrected for barometric changes. The importance of this reading is apparent when it is considered that a drop of one inch of mercury in the turbine's back pressure necessitates an increased steam consumption of 5 to 15 per cent per kwh. produced, depending upon the existing back pressure and the type of turbines. High accuracy is claimed for the instrument because of the mercury column principle employed. Great legibility and sensitiveness are secured by recording only the working part of the range (either 25 to 31 in. or 20 to 31 in. of mercury) over nearly the full face of the chart. The bulletin includes valuable turbine performance data, a list of users, typical charts, sectional views and dimension diagrams, including reference to a new model instrument for flush mounting on panel boards. Six pages, 8½ x 11 in.

COMING MEETINGS

May 3-6—American Society of Mechanical Engineers. New England regional meeting, Providence, R. I. Calvin W. Rice, 29 West Thirty-ninth Street, New York, secretary.

* * *

May 13-15—American Gear Manufacturers' Association. Annual meeting at Book-Cadillac hotel, Detroit. T. W. Owen, 2443 Prospect Avenue, Cleveland, secretary.

* * *

May 20-21—American Society for Steel Treating. Spring sectional meeting, Hotel Bond, Hartford, Conn. W. H. Eisenman, 4600 Prospect Avenue, Cleveland, secretary.

* * *

June 7-10—Exposition and Convention of Association of Iron and Steel Electrical Engineers at Hotel Sherman, Chicago. John F. Kelly, 1007 Empire Building, Pittsburgh, Pa.

* * *

June 21-25—American Society for Testing Materials. Annual Convention at Chalfont-Haddon Hall, Atlantic City, N. J. C. L. Warwick, 1315 Spruce Street, Philadelphia, Pa., secretary.

* * *

September 1, 2 and 3—American Railway Tool Foremen's Association. Annual convention and exhibit, Hotel Sherman, Chicago. G. G. Macina, secretary, 11402 Calumet Avenue, Chicago, Ill.

* * *

September 20-24 — American Society for Steel Treating. Annual Convention and National Steel and Machine Tool Exposition at Municipal Pier, Chicago, Ill. W. H. Eisenman, 4600 Prospect Avenue, Cleveland, Ohio, secretary.

Experiments on Furnace Linings

The Bureau of Mines is continuing a study of requirements for open hearth furnace refractories. The purpose of the investigation is to determine the condition to which refractories are subjected in open hearth furnaces. During the past year accurate determinations were made of the temperatures existing in various parts of a basic furnace. The temperature gradients through wall and roof bricks also were determined. A large number of dust samples were taken from the furnace gases in an attempt to determine their source and composition and the nature of their attack upon refractories.

MAY 3 1926

The Blast Furnace and Steel Plant

Member of the Audit
Bureau of Circulations

PITTSBURGH, PA., MAY, 1926

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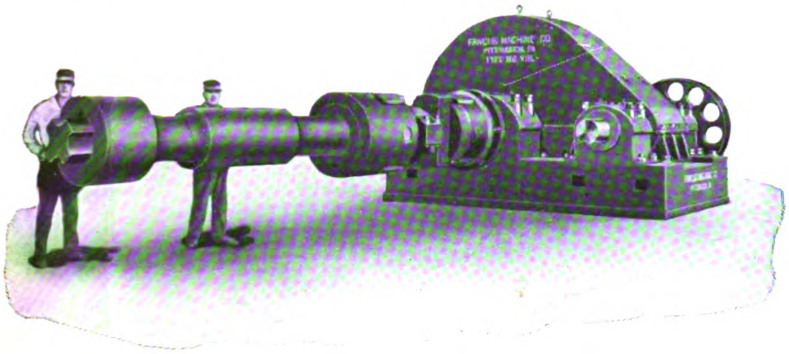
FAWCUS

HERRINGBONE REDUCTION GEAR



and equipment designed and constructed by us for the electrification of a 24″ structural mill, replacing a steam engine.

This drive transmits power from a 3,000 horsepower D. C. motor with operating peak loads of 7000 H. P., the speed of this motor is adjusted constantly from 0 to 485 R. P. M., and arranged for operating as high as 550 R. P. M. at friction speed. The operating mill speed range is from 70 to 105 R. P. M.

This equipment was furnished by us complete as shown in the illustrations, including the Universal Spindle between the existing engine frame and the reduction gear, also the jack shaft and coupling, etc., leading through the engine to the mill.

FAWCUS MACHINE CO.

PITTSBURGH, PA.

REPRESENTATIVES

New York, N. Y.—Presley Hamilton, 149 Broadway
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